March 2008 Version1 Rev 1

CINTEC TERRA COTTA SOLUTIONS

Cintec, working with North American Architects, Engineers, Preservation Consultants and Contractors to provide specialized fixings for Terra Cotta repairs and re-attachment.

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[Please note there are book marks embedded in the electronic document]

CINTEC ANCHOR

A SELECTION OF TYPICAL ANCHORING DETAILS FOR TERRA-COTTA

SPECIAL NOTICE

It is a violation of the Professional License Law to alter any drawing in anyway, unless acting under the direction of a Licensed Professional Engineer. The altering consultant shall affix his/her seal and the notation "Altered" followed by his/her signature and date of alteration.

This bulletin is intended to give a guide to the Cintec Designed Anchor System and is not intended to be fully comprehensive. Cintec in North America, on behalf of itself, its employees, or agents excludes any or all liability what so ever arising directly or indirectly from the use of this bulletin or the Cintec Anchoring System is so far as the exclusion is permitted by Federal or State Law.

Acknowledgements

Cintec would like to thank and acknowledge the help and assistance of **John A. Fidler, RIBA,** Consultant, Preservation Technology, Simpson Gumpertz & Herger Inc Consulting Engineers Los Angeles. **Richard McGuire. PE,** Structural Engineering Associates, Kansas City ,Missouri ,**James W Rhodes. FAIA**, Preservation Design, Croton-on-Hudson NY ,**Philip [Pete] Pederson** ,Gladding Mc Bean ,CA. and all the other Engineers and Architects who have contributed to this bulletin.

FOR ENGINEERING ASSISTANCE FOR PROJECTS VIA E-MAIL CONTACT US AT engineers@cintec.com

CINTEC

REINFORCEMENT SYSTEMS

SECURING THE PAST FOR THE FUTURE

What is Terra-Cotta?

The definition of terra-cotta refers to a high grade of often blended, weathered or aged clay which, when mixed with sand or pulverized fired clay is called "grog". This can be molded and fired at high temperatures to a hardness and compactness not obtainable with brick. A class A Engineering brick as found in the UK and best red terra-cotta would not be far apart. The word terra-cotta is derived from the Latin word terra-cotta—literally; "cooked earth" terra-cotta clays vary widely in color according to geography and types, ranging from red and brown to white. Historically, the color of the terracotta was a very good indication of the overall properties of the material because the color of the clay determined the final color and certain clay types could only be fired at certain temperatures in order to achieve those colors. For example, the reds and deep browns were made from Fire Clay and were able to be baked at high temperatures to provide the strongest, least porous terracotta. At the other extreme, the light brown/buff terracotta was made using a kaolinitic clay which had to be burnt at low temperatures and thus was relatively weak and porous. By the 1900s englobe **[Liquid clay dip or spray applied as finish coating then fired to provide a different colour to underbody or biscuit Sometimes known as slip glaze. Differs from lead, tin and other clear glazes that add gloss to underbody]**finishes were being applied to mimic stones etc and so the color indications no longer worked because the slip glaze finish could be designed in any color. . Terra-cotta is usually hollow cast with several means of manufacture: "hand-pressed" into plaster moulds; molded by hand; extruded and slip cast blocks which are open to the back, like boxes, with internal compartment-like stiffeners called webbing. Webbing substantially strengthens the load-bearing capacity of the hollow terra-cotta block without greatly increasing its weight, but not always. It certainly stiffens the wet clay while drying, but are often undercut near the walls

Ram Press

Extrusion

Terra-cotta blocks are often finished with a glaze; that is, a slip glaze (clay wash) or englobe finish applied before firing. Glazing changed the color, imitated different finishes, and produced a relatively impervious surface on the weathering properties when properly maintained. It had rich color and provided a hard surface that was not easily chipped off. Glazing offered unlimited, fade-resistant colors to the designer. Even today, few building materials can match the glazes on terra-cotta for the range and, most importantly, the durability of colors. Poor "glaze fit" would mean crazing and flaking glaze.

Glazed architectural terra-cotta has many material properties similar to brick or stone. It also has many material properties radically different from traditional masonry materials. It is those differences which must be considered for a better understanding of some of the material characteristics of glazed architectural terra-cotta when it is used as a building material. Terra Cotta has a relatively high compressive strength but weak in shear and tension, especially from forces exerted by corroding ironwork.

Glazed architectural terra-cotta probably comprises one of the largest if not the largest constituent material in some urban environments today. However, the infinite varieties of glazing have hidden this fact from the casual observer. One of the attractive features of glazed architectural terra-cotta in its time was that it could be finished (glazed) in exact imitation of stone. In fact, many professionals are often surprised to discover that what they presumed to be a granite or limestone building is glazed architectural terra-cotta instead.

Deterioration:

Deterioration is, infinitely complex - - particularly when glazed architectural terra-cotta has been used as a cladding material.

Deterioration creates a “domino” like breakdown of the whole system: glazed units, mortar, metal anchors, and masonry backfill. In no other masonry system is material failure potentially so complicated.

The root of deterioration in glazed architectural terra-cotta systems often lies in a misapplication of the material. Historically, glazed architectural terra-cotta was viewed as a highly waterproof system needing neither flashing, weep holes nor drips. This supposition, however has proved to be untrue, as a serious water-related failure was evident early in the life of many glazed architectural terra-cotta clad or detailed buildings.

No one case of deterioration in glazed architectural terra-cotta is ever identical to another owing to the infinite number of variations with the material: original manufacture, original installation inconsistencies, number of component parts, ongoing repairs or the various types and sources of deterioration. However, certain general statements may be made on the nature of glazed architectural terra-cotta deterioration.

As with most building conservation and rehabilitation problems, water is a principal source of deterioration in glazed architectural terra-cotta. Terra-cotta systems are highly susceptible to such complex water-related deterioration problems as glaze crazing, glaze spalling and material loss, missing masonry units and DETERIORATED METAL ANCHORING, among others.

Example of steel beam corrosion causing failure of the decorative terra cotta facade.

Corroded restraint fixing.

Deterioration of Metal Anchoring:

Deteriorated anchoring systems are perhaps the most difficult form of glazed architectural terra-cotta deterioration to locate or diagnose. Often, the damage must be severe and irreparable before it is noticed. Water which enters the glazed architectural terra-cotta system can rust the anchoring system and substantially weaken or completely disintegrate those elements. Total deterioration and the lack of any anchoring system may result in the loosening of the units themselves, threatening the architectural or structural integrity of the building. Recently, falling glazed architectural terra-cotta units have become a serious safety concern to many building owners and municipal governments. Early detection of failing anchoring systems is very difficult.

Repairs to Deteriorated Anchors and Iron Work:

The source of moisture must be determined and rectified to mitigate further corrosion of the anchors and original iron work. Serious consideration should also be given to stabilizing the original iron work and anchors which will continue to rust and jack even if no longer performing any structural service. One way to deal with this problem is to use Cathodic / Impressed current protection.

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Enhanced Fixing Technology For Terra Cotta and Hollow Masonry Units

The Cintec anchor is inserted into a predrilled hole.

The injection equipment is attached to the anchor and inflation commences under a pressure of 42PSI.

Grout is pumped into the hollow steel section which flows into the socked area via a number of flood holes.

As the anchor fills, grout milk flows through the sock creating a chemical bond between anchor and substrate.

After approximately 15 seconds the anchor is totally inflated with a concrete grout giving a mechanical fixing. In addition the grout milk has passed through the sack forming a chemical bond to the substrate.

In a test carried out by an independent laboratory on a building of similar material, arial pull results in excess of 3000lbs were achieved.

CINTEC

DESIGNED ANCHOR SYSTEMS FOR THE CONSTRUCTION INDUSTRY

Engineering Design for Terra Cotta Repairs and Stabilization

Terra Cotta (TC) sections appear to be fragile and brittle. However the material itself is strong.

This is borne out by the fact that our historic terra cotta is not deteriorating faster, and most deterioration is caused by factors external the units themselves.

ASTM C67 specifies a minimum compressive strength of 6,000 psi, shear strength of 1,500 psi and a glaze adhesion bond of 1,200 psi for new terra cotta units.

We believe that the historic terra cotta elements found in North America will meet or exceed these values.

The challenge lies in the thin walls of the units. Minimum face thickness is 1" according to good practice.

The cross walls or webs are another matter. We find that ½" is typical and recommend this value as a maximum if site verification is not possible.

The most common failure modes are:

1. cracking due to oxide jacking of embedded or adjacent metals.
2. loss of support and attachment due to corrosion of attachments.

The most common details we are asked to deal with on historic terra cotta facades are very similar to Plates 25, 26 and 27 of the National Terra Cotta Society manual which now forms part of Cintec's North American Terra Cotta Solutions manual.

In these details the corbelled or cantilevered TC cornice has come loose from its fastenings, which have been lost to corrosion.

The solution as overlaid on these plates is to add a cantilevered horizontal anchor into sound (minimum imbed is six inches) back up beyond the inner edge of the TC unit. These anchors then act as cantilever brackets, transferring the vertical load of the TC unit by bearing on the Cintec grout bulb formed within the hollow interior of the TC unit.

Any outward separation of the unit is arrested by the grout bulb within the void in the unit.

A second anchor is installed vertically to reattach the dentil units under the main cantilevered unit. These units were typically attached by J bolts to the upper units. The J bolts are the first to corrode through and are usually the first sign that the cornice is failing.

Full scale testing was performed on a similar TC unit taken from a High School in New York. The bond of the grout bulb on the inside faces of the TC unit, and the mechanical keying of the expanded grout bulb within the void allowed the anchor to develop sufficient transfer of load to fail the TC unit in diagonal tension in the top and bottom faces. The anchor and its bond remained intact after failure.

The load was applied in tension to the anchor at the back face of the unit, away from the unit. A testing bridge was used to ensure that the load was transferred to the TC unit. The failure load was 4,600 pounds.

When the shell of a TC unit must be relied on to transfer a load, typically pull out, diagonal tension within the shell is calculated to determine the cone failure load. We typically use 10 psi unfactored (allowable) for this value. This is very conservative in view of the high compressive strength these units provide. But caution is warranted because of the thin sections. The strength of the original units can be reduced near corners and thicker decorations where firing of the clay may not be uniform.

The thin sections around a hole drilled for the anchors may also be damaged by the drilling. Years of experience have proven that air cooled dry diamond core drilling should exclusively be used. Hammer drilling will put more stress on the TC section, causing spalling on the back web of the section and can cause fracture cracks.

The above deals with reattaching existing TC units in place.

Cintec has developed solutions for anchoring one or more new TC units within a line of existing units where a TC unit has to be replaced. See Cintec's North American Terra Cotta Manual or www.cintec.com

For additional information please contact 1 613 225 3381 / 1 800 363 6066 or review more information at www.cintec.com

Fire Rating

Cintec anchors are fire resistant

Building Research Establishment
Garston Watford WD2 7JR
Telephone 0923 894040 Telex 923220 Fax 0923 664010

Direct line 0923 66
GTN 3532

Mr. J. Dymmock
Cavity Lock System
Factory Road
Newport
Gwent
NP9 5FA

your reference

our reference BRE/67/50/1

date 23/11/93

Sent by FAX to : 0633 246110

Dear John

Fire testing of the Cintec remedial cavity wall ties.

In the latest test in our fire test rig with a static dead load on each tie of 1.3kN your tie survived a two hour test without failure of any of the three replicate samples.

All three samples are now placed in the upper half of the wall and would have reached several hundred degrees in the part of the tie nearest the fire face.

This indicates that this tie system can, when installed using the correct techniques, be recommended for repair work to buildings having a fire period requirement of up to 2hrs.

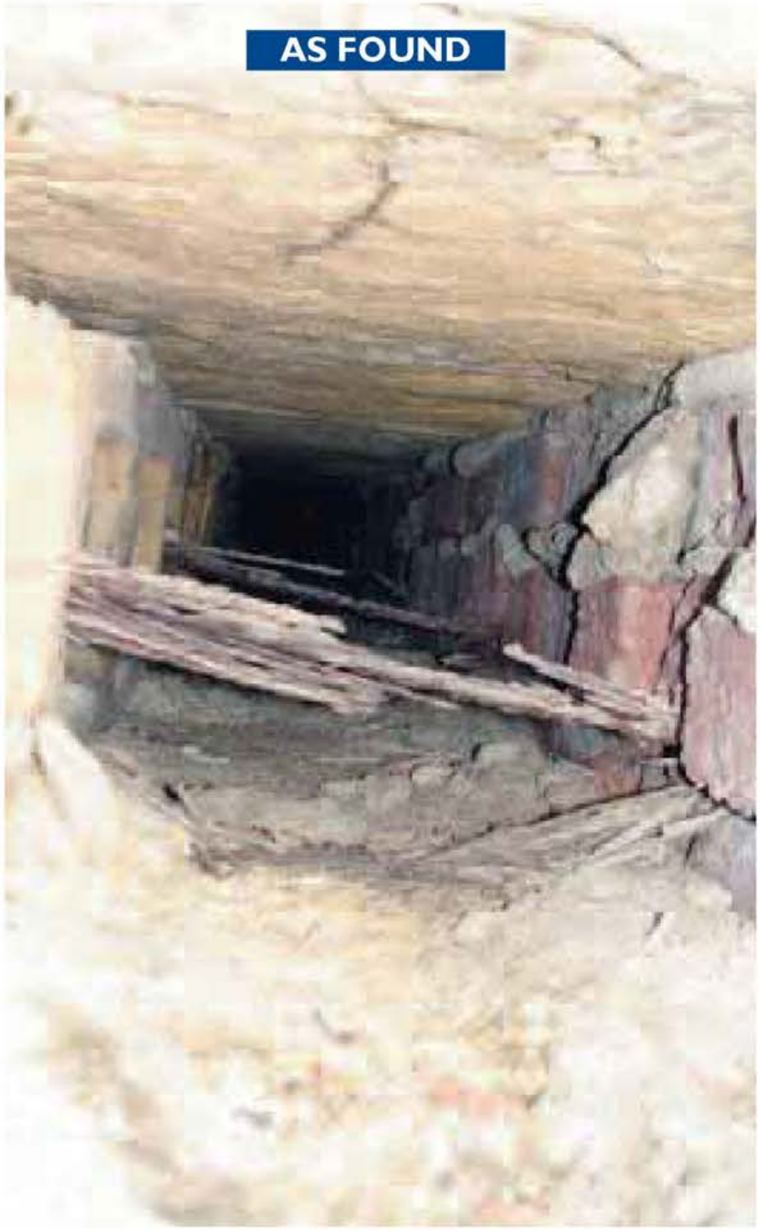
Yours sincerely

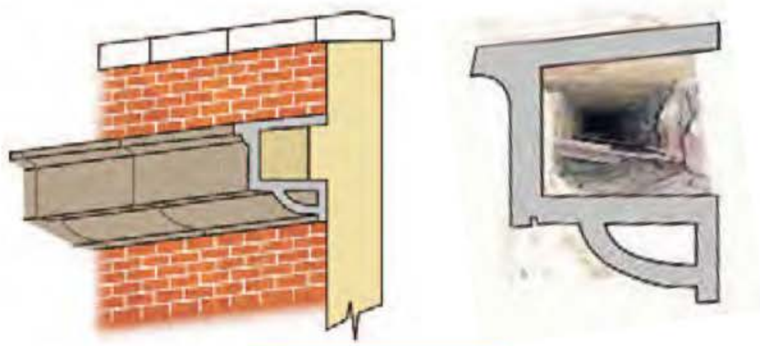
R.C.de Vekey

Head of Masonry Structures Section, Structural Design Division, Geotachnics and Structures Group

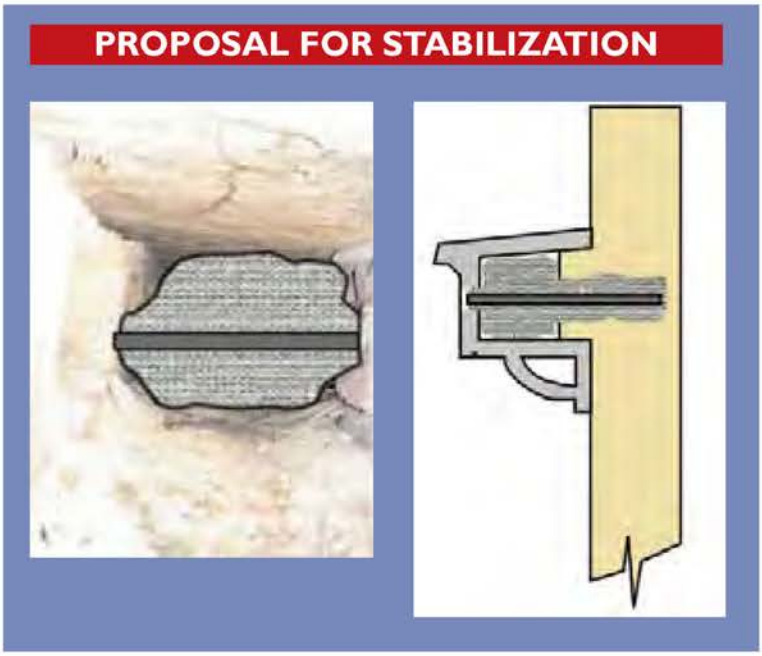
See Cintec's website for 2 hour laboratory testing results
www.cintec.com

Inside Detail on Terra Cotta Repairs and Stabilization





Over time the steel hangers that hold back the terra cotta corrode. When this happens you have the potential for sections, or pieces, of the terra cotta to fall off the structure. The challenge is how to secure the new pieces to the existing facade, or how to stabilize the existing. Cintec has designed a stainless steel anchoring system that is compatible with the terra cotta and the substrate. The system has a 2 hour plus fire rating and can be installed to be invisible. There is no other anchor system, in the world, that offers this level of design flexibility.



Proposed terra cotta design retrofit of the Union Station Power House in Kansas City, Missouri.

Design included by permission of SE of record Richard McGuire. PE,. Structural Engineering Associates, Kansas City, Missouri.

Typical anchor detail Cintec M16 ⅝th" Dia body 3" Dia sock set into 1½" Dia hole subject to field conditions and requirements.

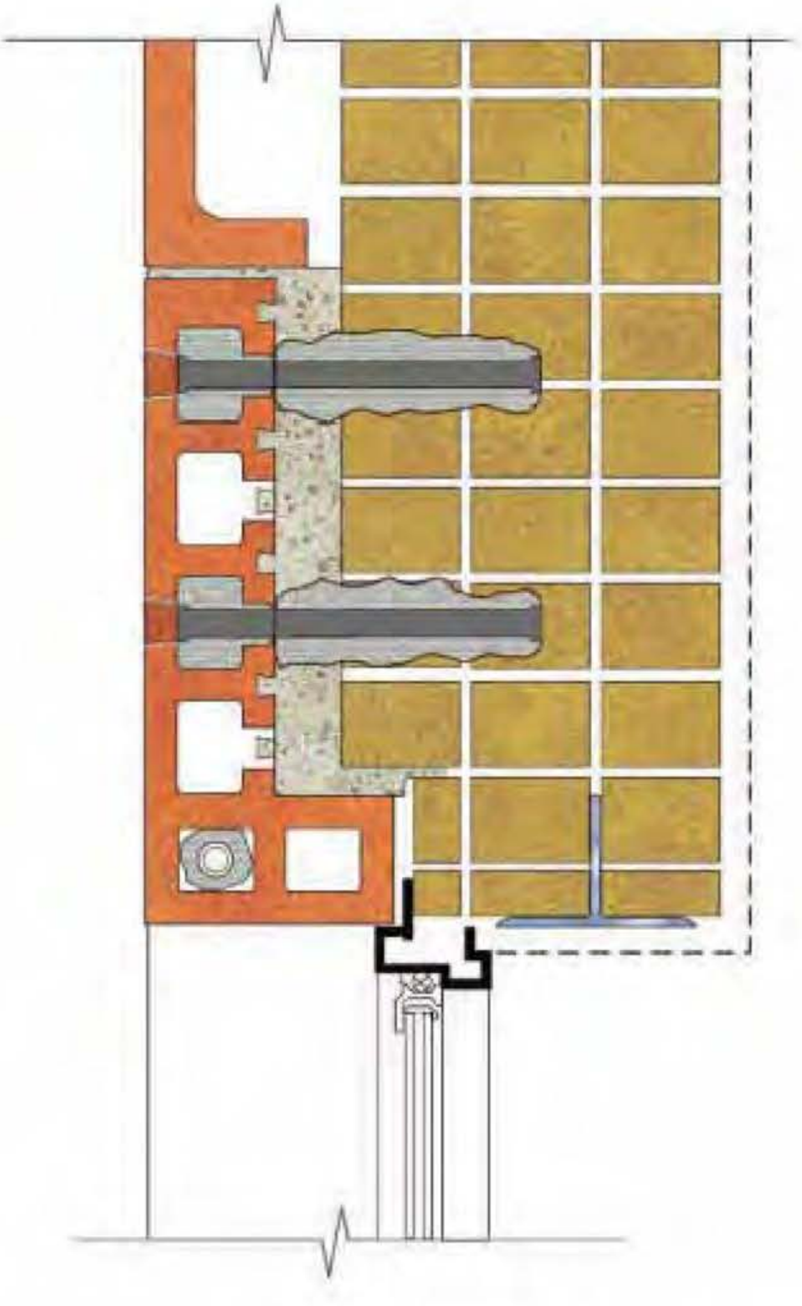


PLATE 1

FIXING TERRA COTTA CLADDING TO BRICK BACK UP

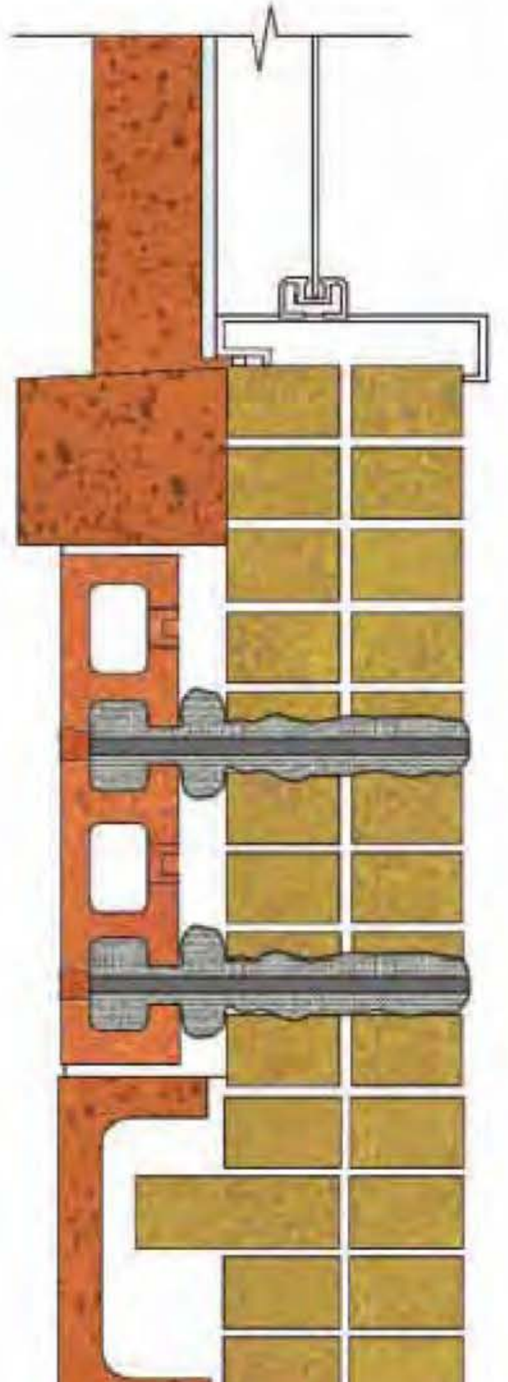


PLATE 2

FIXING TERRA COTTA CLADDING TO BRICK BACK UP WITH AIR GAP

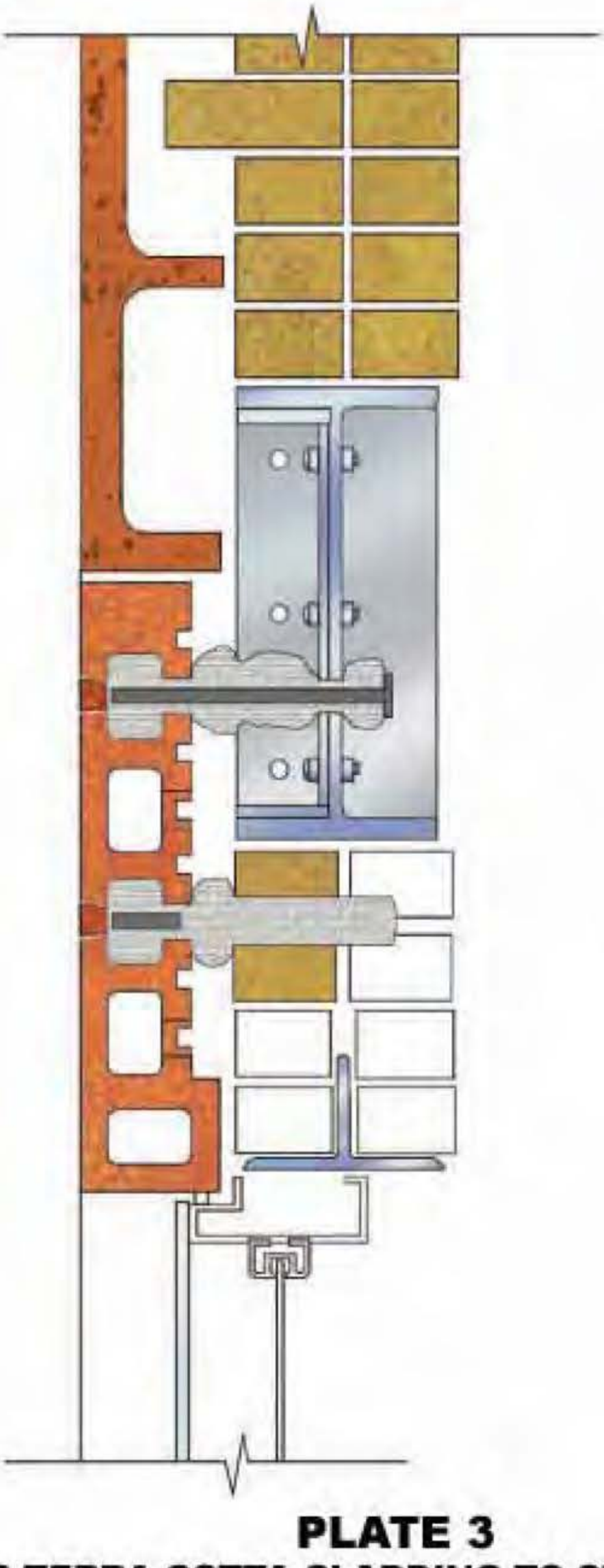


PLATE 3
FIXING TERRA COTTA CLADDING TO STEEL SPANDREL AT WINDOW HEAD

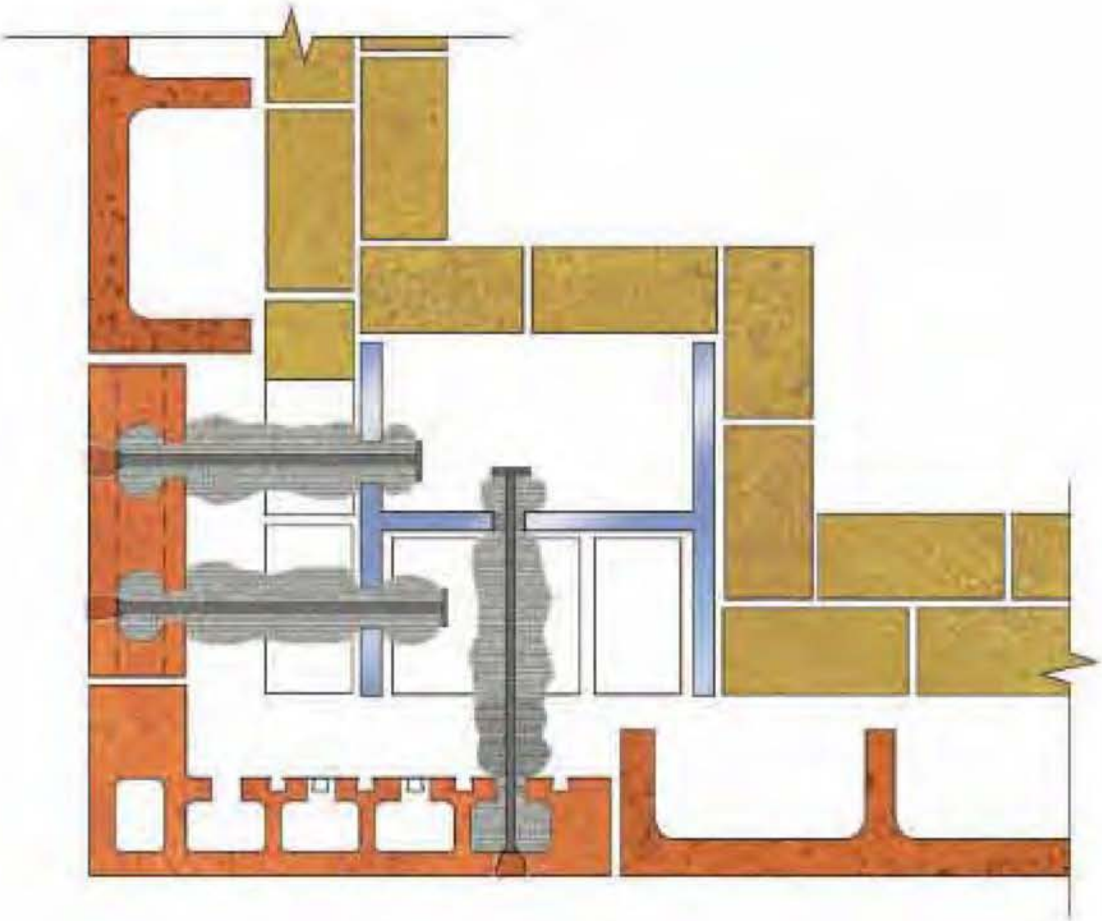


PLATE 4
FIXING TERRA CLADDING TO A STEEL COLUMN

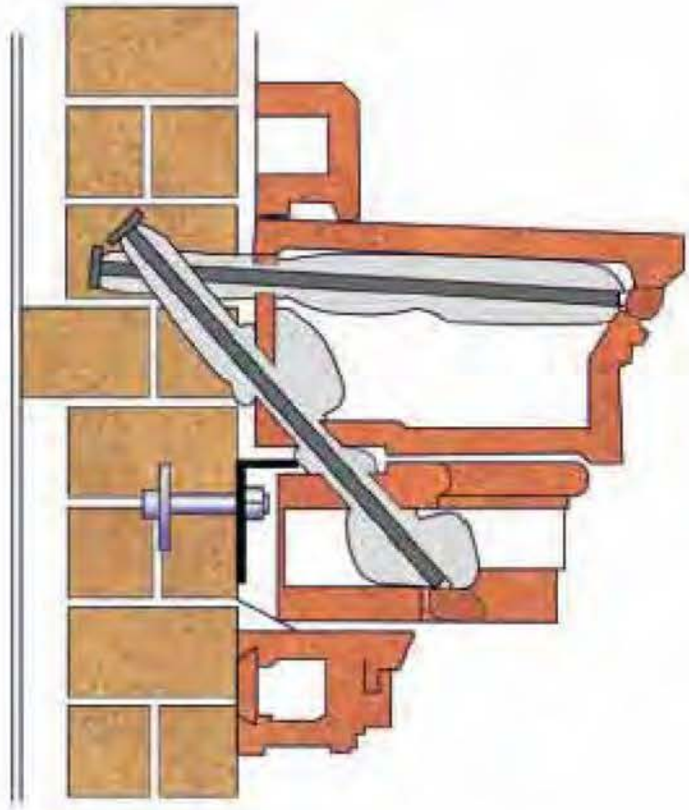


PLATE 5
FIXING TERRA COTTA CORNICE TO BRICK PARAPET

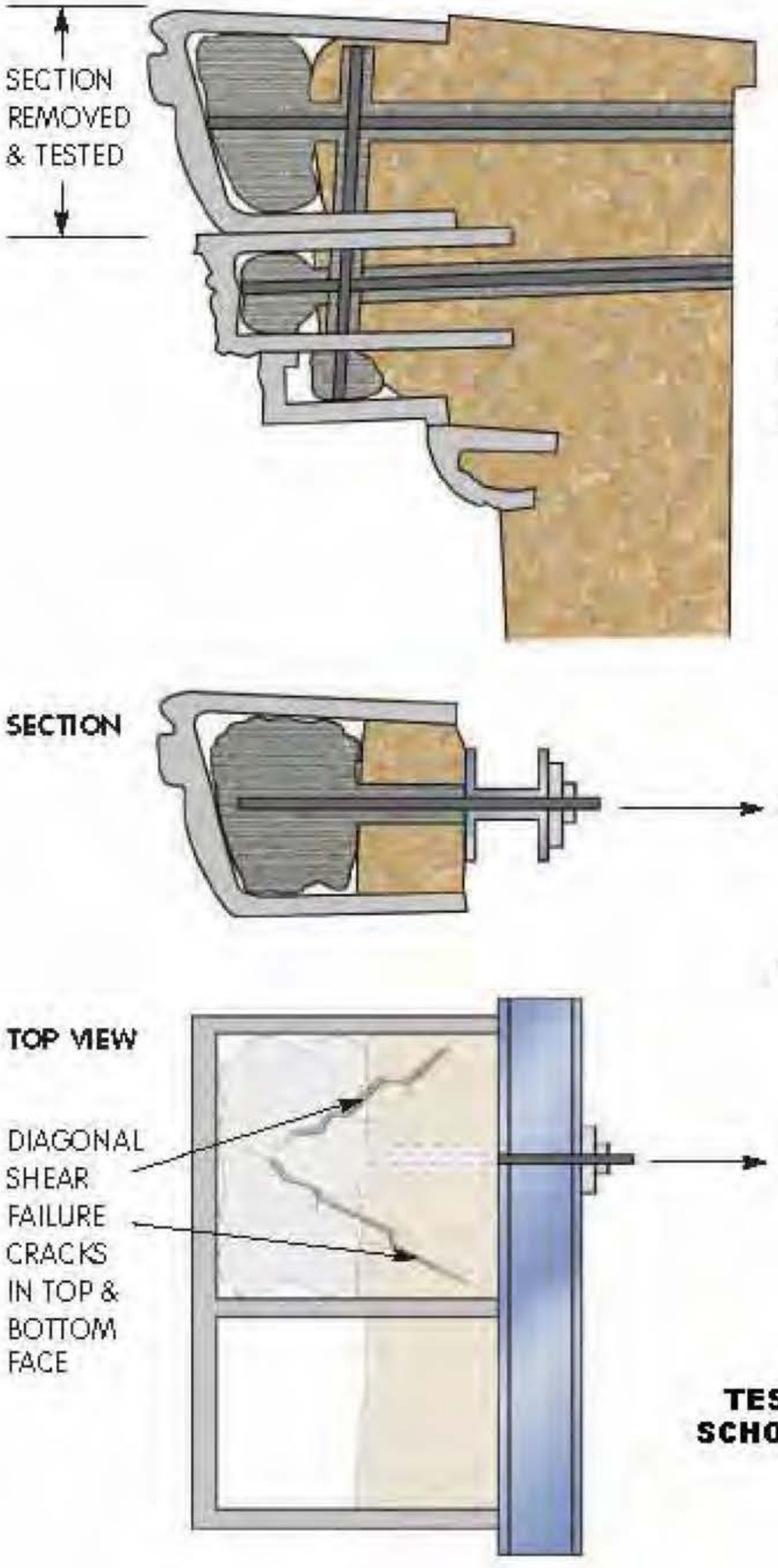


PLATE 6

TESTING DETAILS FOR NEW YORK SCHOOLS CONSTRUCTION AUTHORITY PS 230 K

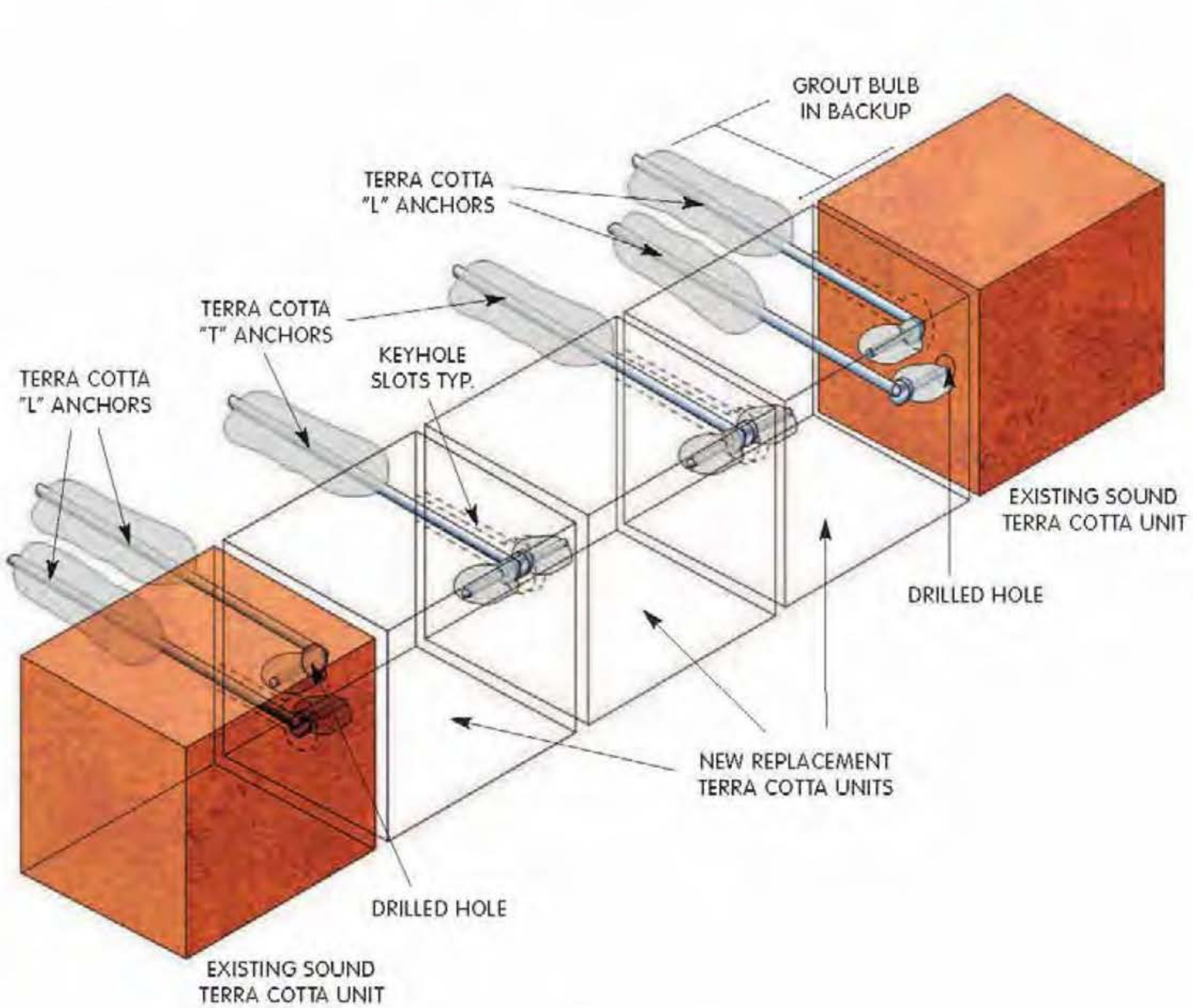


PLATE 8

INSERTING NEW TERRA COTTA UNITS BETWEEN EXISTING UNITS

Cintec repair details base upon

TERRA COTTA

· STANDARD · CONSTRVCTION

REVISED EDITION

Cintec anchor type A

CINTEC STAINLESS STEEL (304) M10 ANCHOR

3/8"th dia body
2" diameter sock
Set into a 1½" diameter hole

Cintec anchor type B

CINTEC STAINLESS STEEL (304) M16 ANCHOR

5/8"th diameter body
3" diameter sock
Set into a 1½" diameter hole

NATIONAL
TERRA COTTA SOCIETY
19 WEST 44th STREET U · S · A NEW YORK, N. Y.
1927

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Introduction

The present volume is a revision of Architectural Terra Cotta—Standard Construction, originally published in 1914.

Like the previous issue, this edition does not presume to suggest architectural design. It shows illustrative architectural forms of assumed proportions, and their proper constructional features. It shows the correct use of Terra Cotta. For a number of examples several good solutions of the structural problems are possible. Variations in size of similar sections sometimes necessitate radical changes in both jointing and construction.

The changes made in this revision are the result of a more extended experience in manufacturing and in modern building methods, and are based on a careful study of the behavior and weathering properties of exterior building materials.

The following are the most important of the structural principles upon which this revision has been developed:

Shelf Supports — In concrete or steel frame buildings, the veneer or facing material should be fully and continuously supported, at each floor level on shelf supports, of adequate strength and stiffness, rigidly connected to the structural frame. Steel shelf angles or supports, in all cases, should be located in mortar joints. The strength of the Terra Cotta should not be unnecessarily reduced by cutting the webs to receive the steel.

Expansion Joints — Proper provision should be made for expansion joints, at shelf supports, over column caps, etc., to prevent the development of disruptive stresses caused by deflection, wind pressure, temperature changes, settlement and like forces.

Terra Cotta on Concrete Frames — The volume changes incident to the setting and hardening of concrete, and the variations in volume of concrete due to humidity and temperature conditions, require provisions to allow free movement of the supporting frame and make it undesirable to completely fill a facing applied to a concrete structure.

Protection against Corrosion — Proper care should be exercised to prevent the corrosion of all steel supports, ties, etc. Where such protection cannot be permanently secured through encasement with mortar or concrete, or through the use of corrosion resistant metallic coatings, non-corrosive metals should be employed.

Free-standing Construction — Exposed free-standing construction, subject to the absorption of water through mortar joints and liable to injury from subsequent freezing, or the expansion of improper filling material, should generally be left unfilled and should be ventilated by means of small, inconspicuously placed weep-holes (indicated by W. H. on the plates).

Flashing and Drips — Properly constructed flashing should be provided to cover the top of large projecting horizontal courses, the backs and tops of parapet walls, wide-exposed sill courses, etc., and all projecting features should have drips.

Terra Cotta

A brief synopsis of the manufacture of Terra Cotta

Drawings The architect's complete scale drawings and steel framing plans are furnished the manufacturer, who, following the design, makes scale shop drawings showing the jointing and construction, and full size details to the proper shrinkage dimensions. These drawings are submitted to the architect for approval before proceeding with the work.

Models and Moulds Full size models to shrinkage scale are made of plaster for each different shape shown on the shop drawings. Over these models sectional moulds of plaster are cast, from which later the required number of pieces of Terra Cotta are produced.

Decoration From the architect's drawings or sketches, in the style and period indicated, modelled ornament is applied in clay to the face of the plaster models. Photographs of the ornamental models are submitted to the architect for approval or he may personally examine these models at the factory—the soft clay permits of such corrections or improvements which may be desired.

Clay The mixture of clays and fusible minerals used in forming the Terra Cotta is carefully selected and proportioned to give the desired degree of plasticity and a composition which, when fired at high temperatures, will produce a homogeneous body, amply strong to carry the required structural loads.

Pressing The foregoing processes are preparatory to actual production, the first step of which is pressing. This is a manual operation and consists of pressing the plastic clay into the mould. The walls of the pieces should not be less than one inch thick, following the contour of the mould, and the partitions should be of such thickness and so spaced as to perform their proper functions with regard to form and structure. The pressed piece remains in the mould until the clay stiffens. It is then removed from the mould and is skillfully retouched. Then it is placed in driers, where the moisture is evaporated.

Color From the drying process, the Terra Cotta passes into the spraying department where, by means of compressed air apparatus, the exposed surfaces are coated with the ceramic mixture which, during the firing process following, develops into the desired color or glaze.

These colors or glazes are prepared with scrupulous care, according to exact ceramic formulae. The variety of shades and textures which may be obtained opens up an unlimited field of permanent color design in architecture.

Firing Following the coloring process, the Terra Cotta is fired in kilns where it is subjected to a temperature rising gradually to 2,000 degrees Fahrenheit or more, depending upon the temperature of maturity of the clay and glaze. After proper firing, the kiln is allowed to cool slowly to normal temperature, an operation that causes a slow annealing of the Terra Cotta.

Terra Cotta is usually fired in periodic muffle kilns. In recent years, the tunnel kiln has been developed for the firing of Terra Cotta. In the latter type of kiln the Terra Cotta is set or loaded on cars, which travel through a long heated tunnel.

Fitting From the kiln, the Terra Cotta is removed to the fitting department, where it is laid out and marked to correspond with the piece numbers shown on the shop drawings. It is also marked to indicate the position it is to occupy in the building. Where required, the joints are squared, or cut to proper alignment and size, either by hand or grinding. Careful fitting is essential to assure satisfactory results in the erected Terra Cotta.

Shipping For rail transportation, Terra Cotta is usually shipped in bulk, securely packed in hay and braced to prevent shifting.

Upon arrival at the building site, the hay should be removed and the Terra Cotta placed in the order marked, in piles on wooden strips.

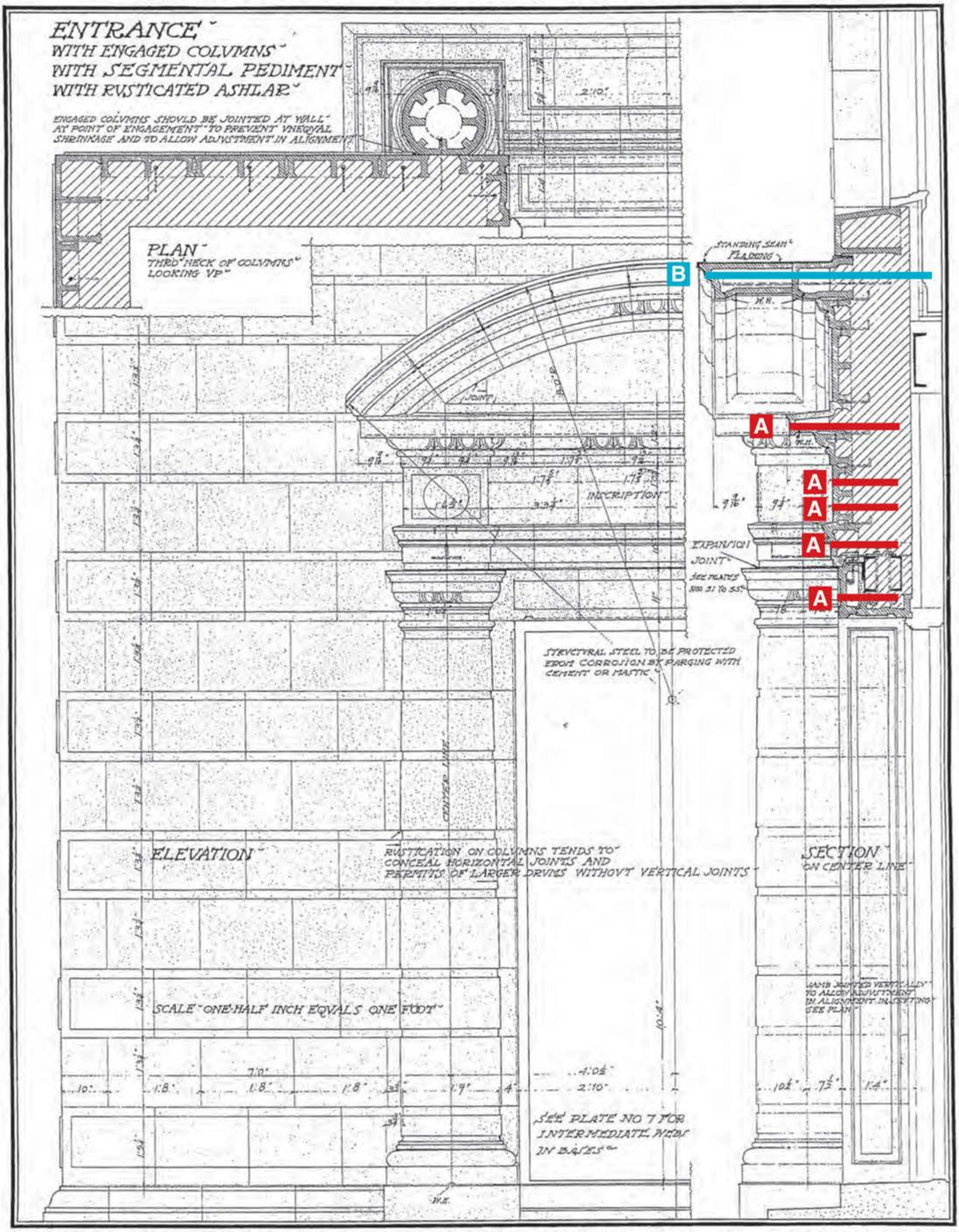
For export by vessel, the Terra Cotta is usually packed in boxes or crates, according to the special conditions encountered. Another method that has been found to be economical and entirely satisfactory is to ship the Terra Cotta loose after it has been wrapped and tied in corrugated cardboard.

Erection The appearance of erected Terra Cotta is greatly affected by inaccurate setting and defective pointing of the mortar joints. As the individual pieces of Terra Cotta have been carefully fitted and numbered to correspond with the erection drawings, the PIECES MUST BE ERECTED IN ACCORD WITH THE NUMBERS THEREON if satisfactory results are to be secured.

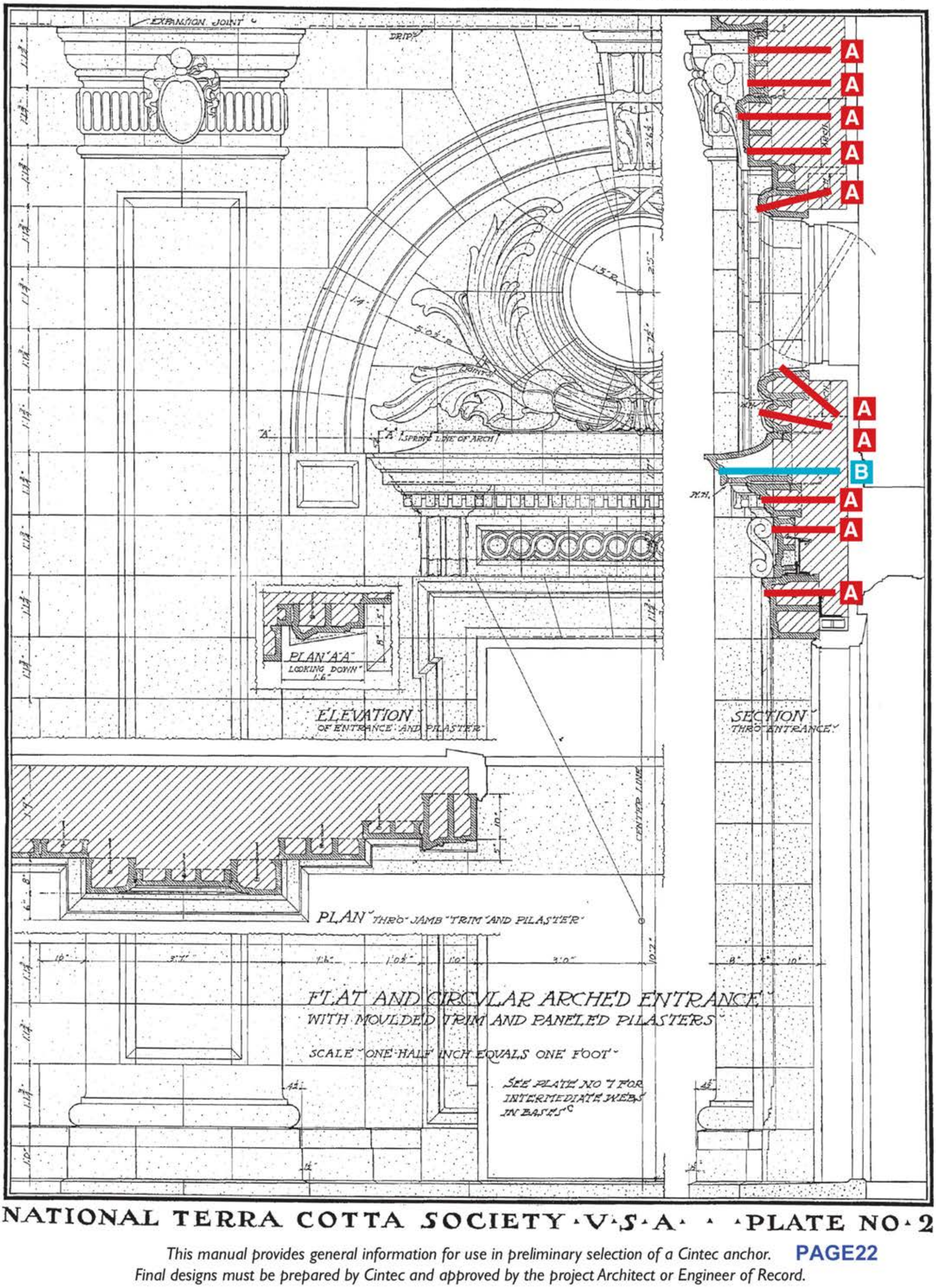
Time The Terra Cotta manufacturer will contract to submit shop drawings for approval within a fixed time after receipt of the architect's drawings and other required information. All shipping dates are computed from the date of receipt by the manufacturer of architect's approval of shop drawings and complete data on color and texture desired. Work cannot be definitely scheduled for production until all essential information is on hand. The process of manufacture may take from six to ten weeks, depending upon the size and architectural character of the order.

Specification and Contract A Standard Specification for the Manufacture, Furnishing and Setting of Terra Cotta and a standard form of contract have been adopted by the NATIONAL TERRA COTTA SOCIETY. They are recommended for general use. A copy of either may be secured by addressing the Society. The specifications are incorporated in this volume.

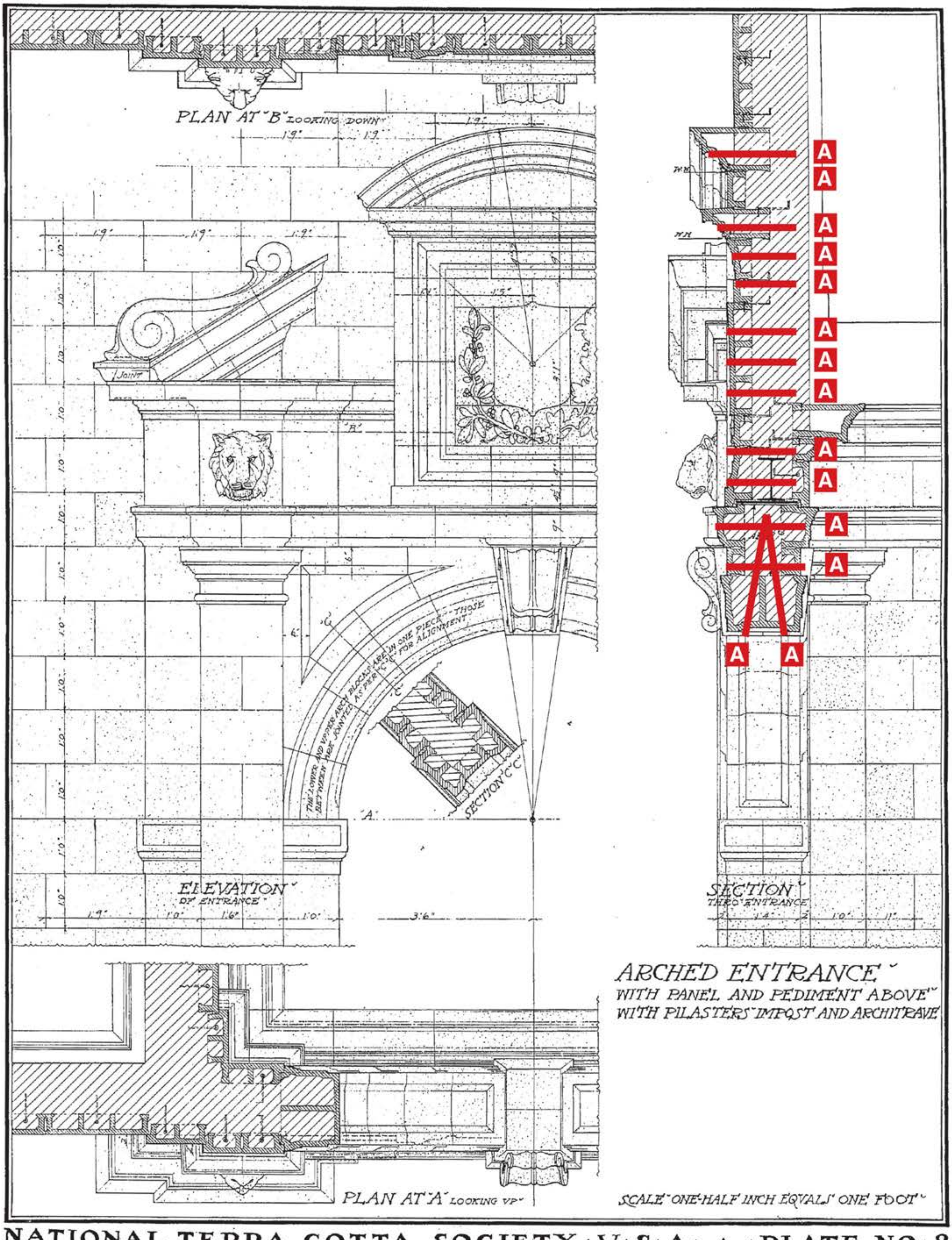
Terra Cotta factories are conveniently located in the Eastern, Central and Western sections of the United States (see list in back of this volume). All of the Society's membership will be glad to have any architect or designer interested in the processes of manufacture of Terra Cotta visit their plants.



NATIONAL TERRA COTTA SOCIETY · U · S · A · · · PLATE NO · 1



NATIONAL TERRA COTTA SOCIETY · V · S · A · PLATE NO · 2



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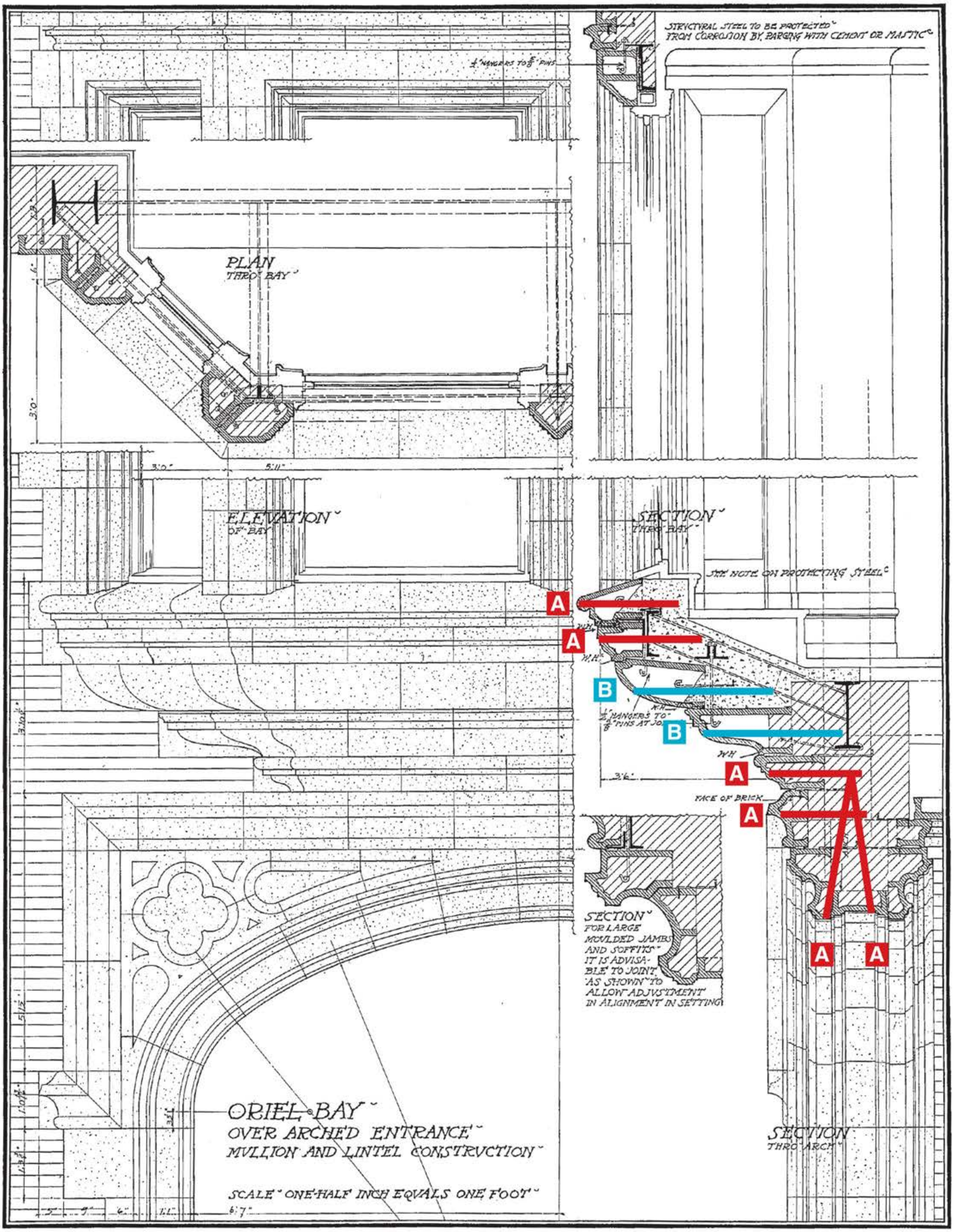
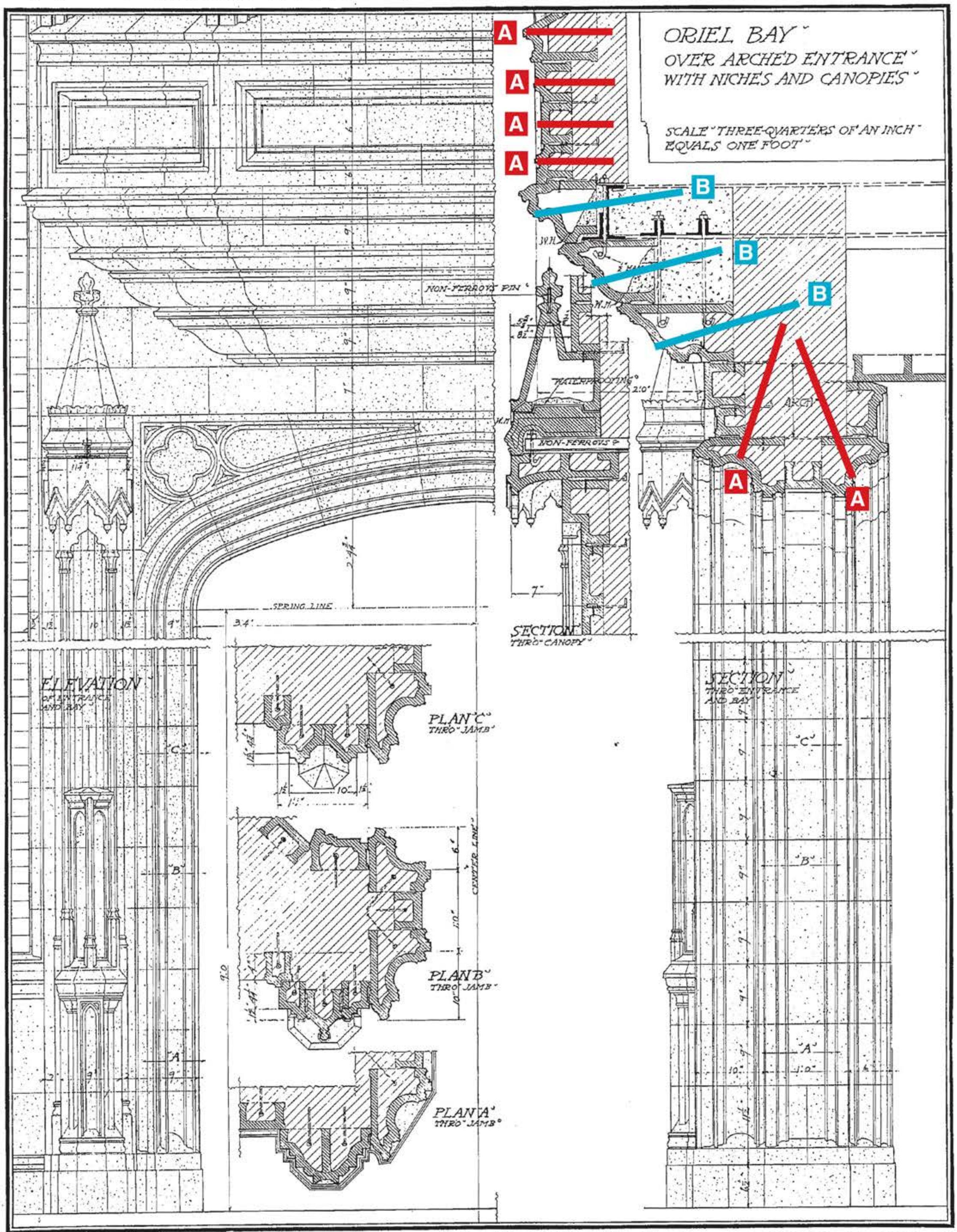
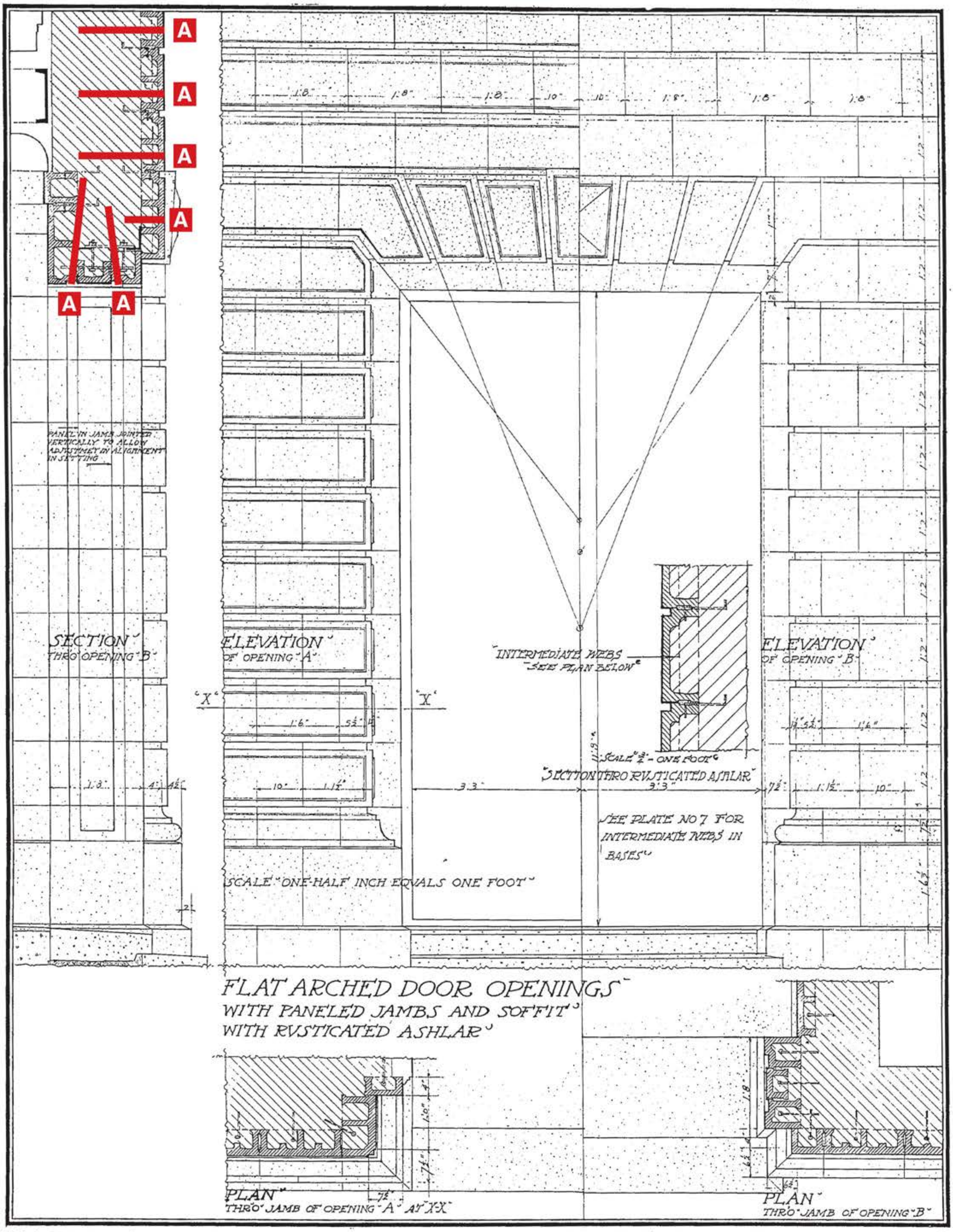
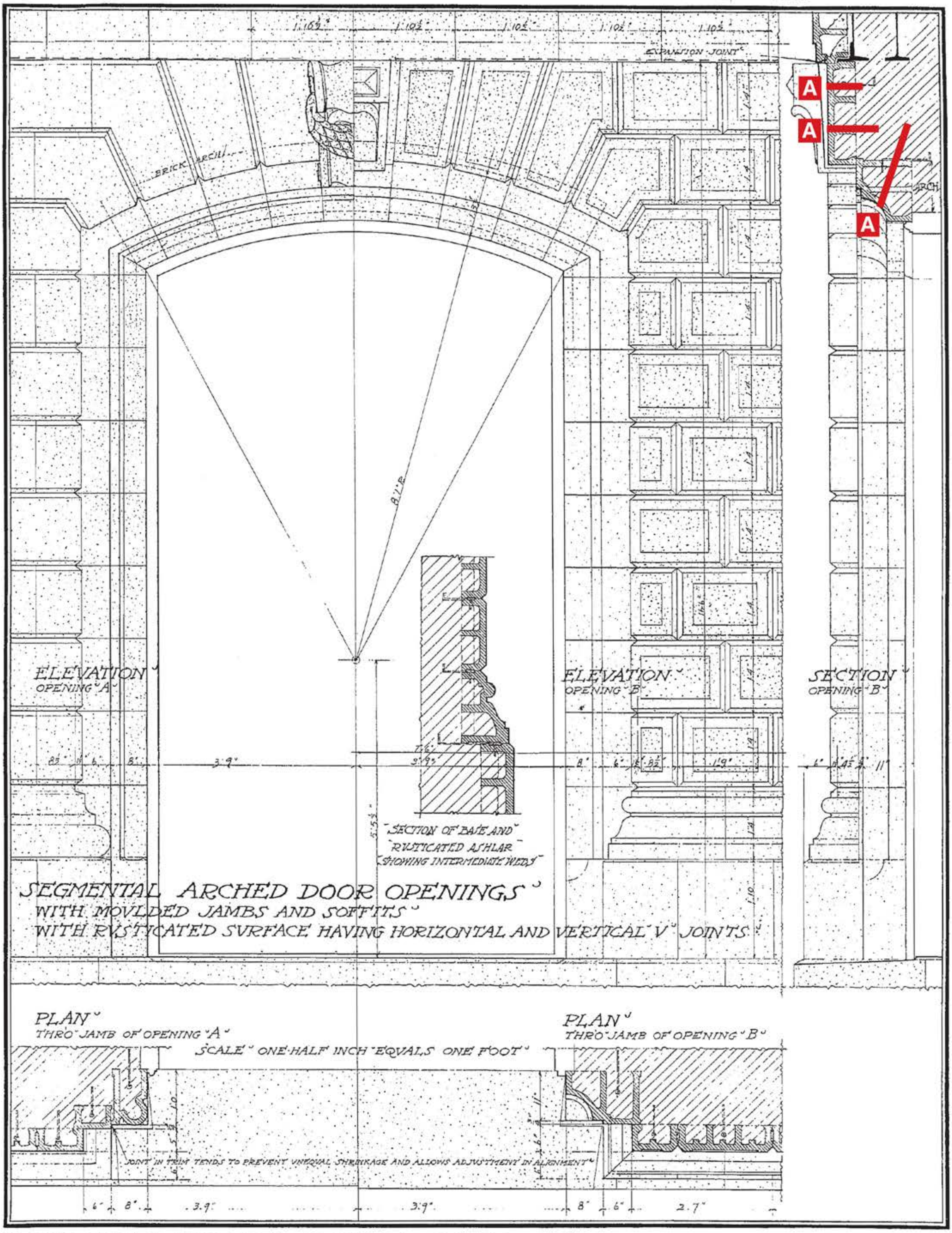

STRUCTURAL STEEL TO BE PROTECTED FROM CORROSION BY PARGING WITH CEMENT OR MASTIC
PLAN THRO' BAY
ELEVATION OF BAY
SECTION THRO' BAY
SEE NOTE ON PROTECTING STEEL
A
A
B
B
A
FACE OF BRICK
A
A
A
SECTION FOR LARGE MOULDED JAMBS AND SOFFITS IT IS ADVISABLE TO JOINT AS SHOWN TO ALLOW ADJUSTMENT IN ALIGNMENT IN SETTING
SECTION THRO' ARCH
ORIEL BAY
OVER ARCHED ENTRANCE
MULLION AND LINTEL CONSTRUCTION
SCALE ONE-HALF INCH EQUALS ONE FOOT

TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U · S · A · · · PLATE NO · 5


A
A
A
A
A
A
SECTION THRO' OPENING "B"
ELEVATION OF OPENING "A"
ELEVATION OF OPENING "B"
"X"
"X"
INTERMEDIATE WEBS SEE PLAN BELOW
SCALE ½" - ONE FOOT
SECTION THRO RUSTICATED ASHLAR
SEE PLATE NO 7 FOR INTERMEDIATE WEBS IN BASES
SCALE "ONE-HALF INCH EQUALS ONE FOOT"
FLAT ARCHED DOOR OPENINGS
WITH PANELED JAMBS AND SOFFIT
WITH RUSTICATED ASHLAR
PLAN THRO' JAMB OF OPENING "A" AT X-X
PLAN THRO' JAMB OF OPENING "B"



This manual provides general information for use in preliminary selection of a Cintec anchor.
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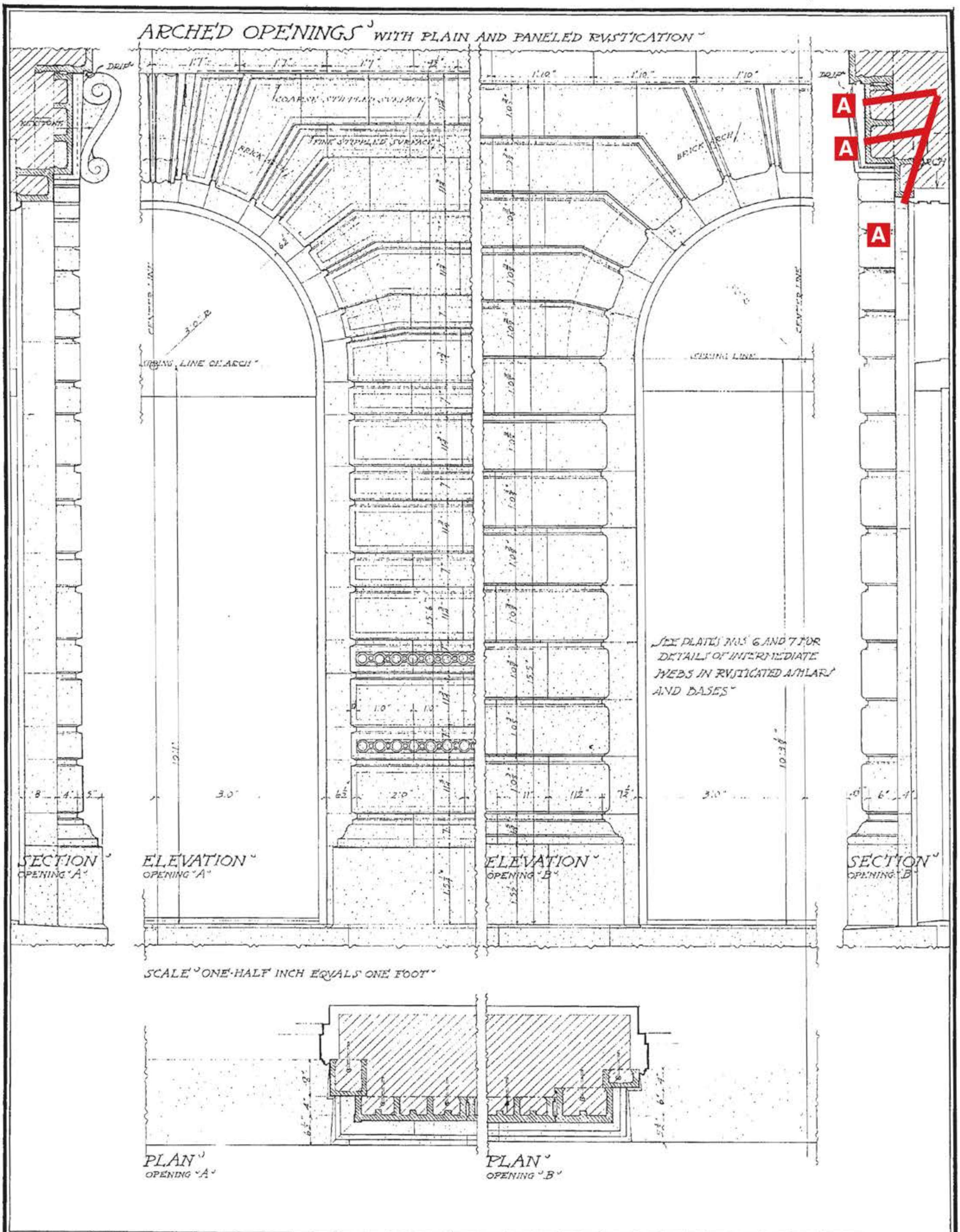

This manual provides general information for use in preliminary selection of a Cintec anchor. **PAGE28**
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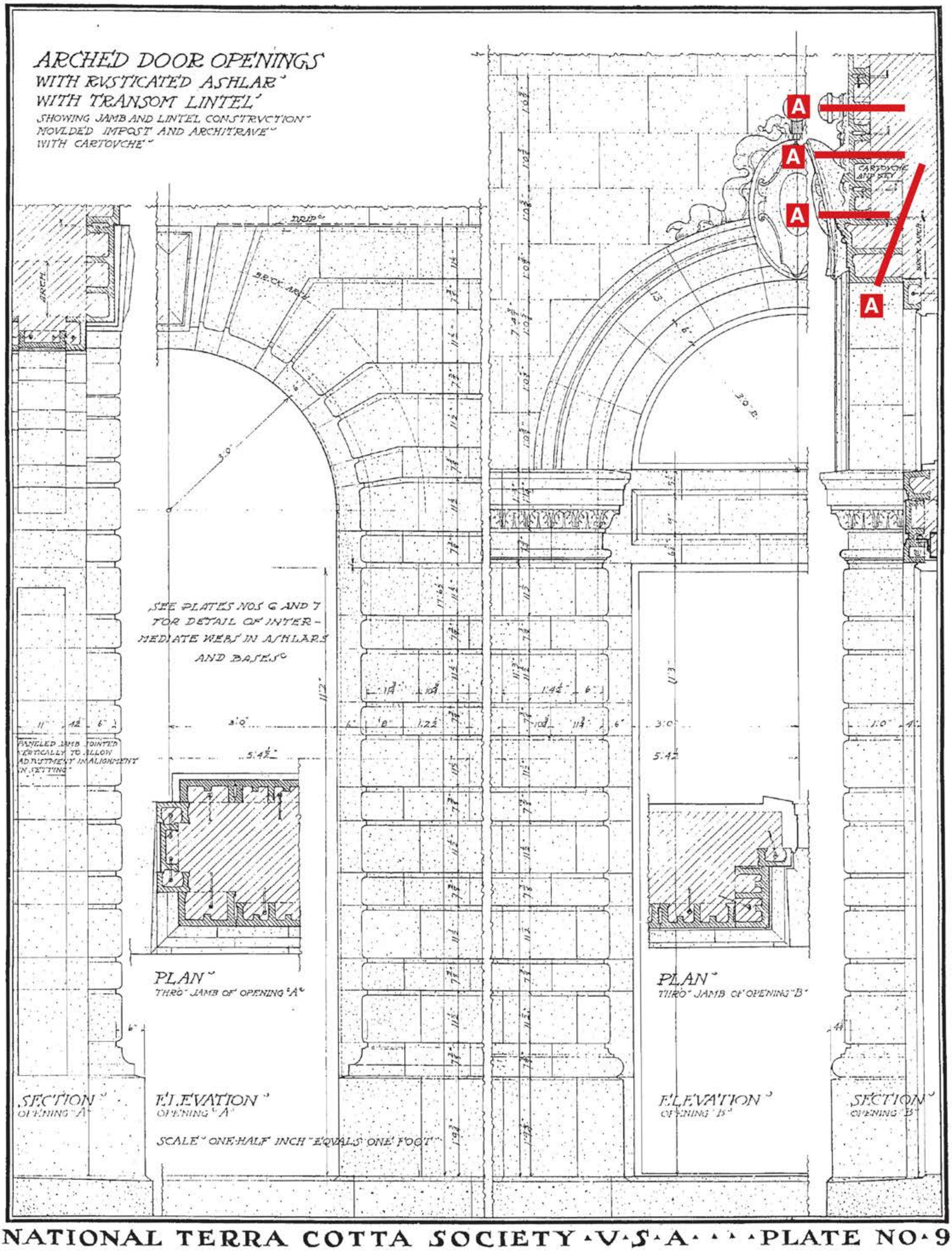
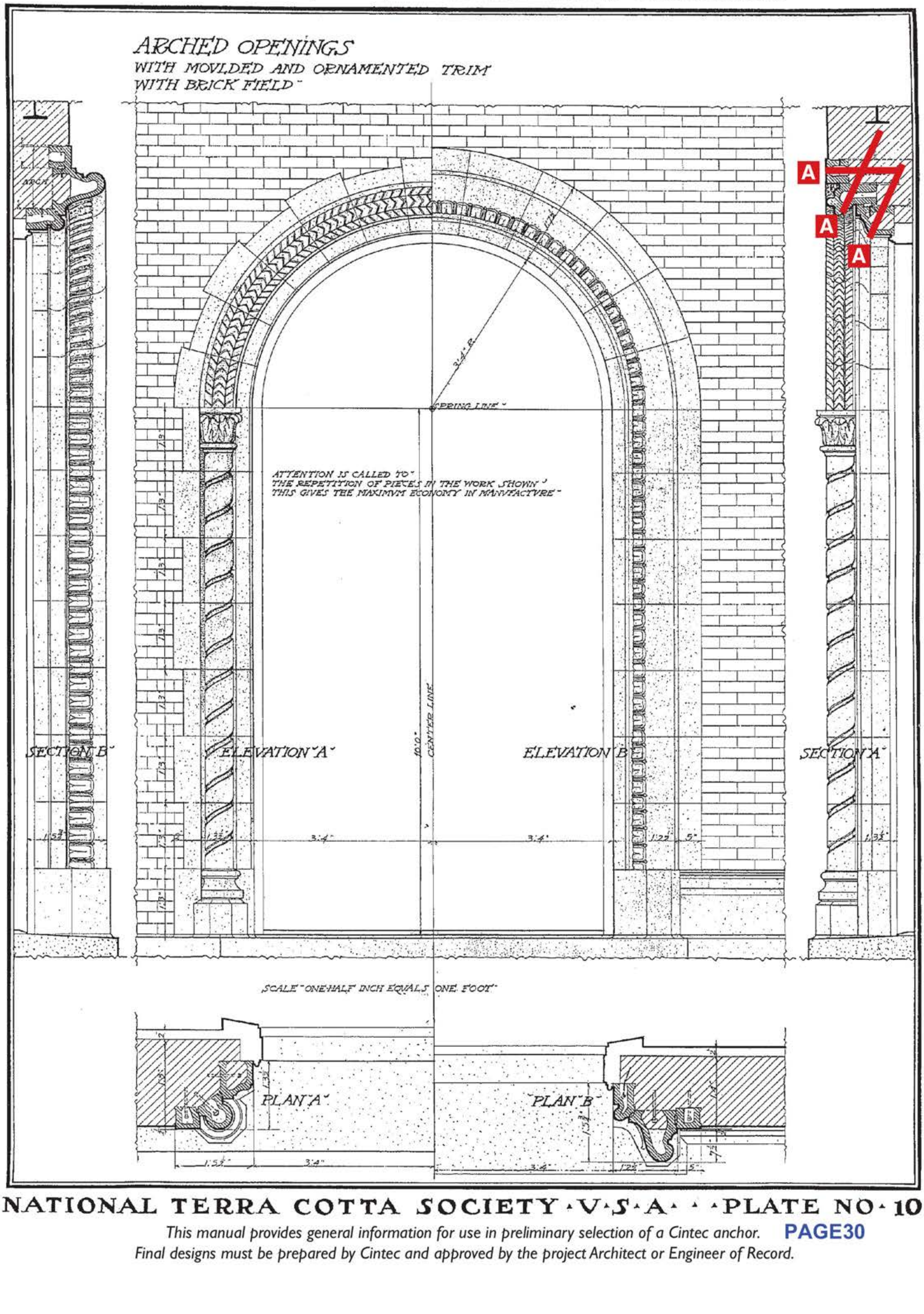
TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U · S · A · · · PLATE NO · 9



This manual provides general information for use in preliminary selection of a Cintec anchor. **PAGE30**
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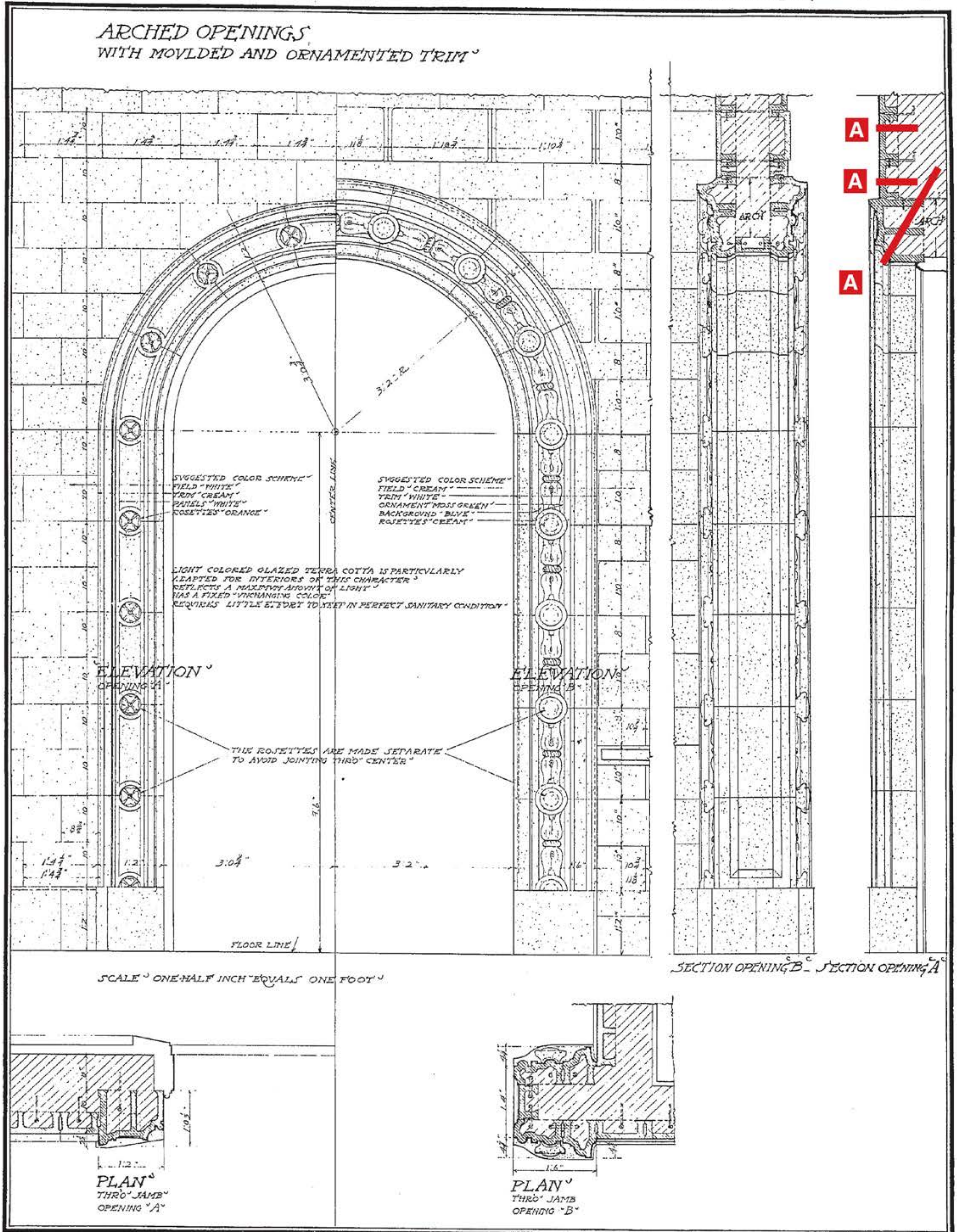

This manual provides general information for use in preliminary selection of a Cintec anchor. **PAGE31**
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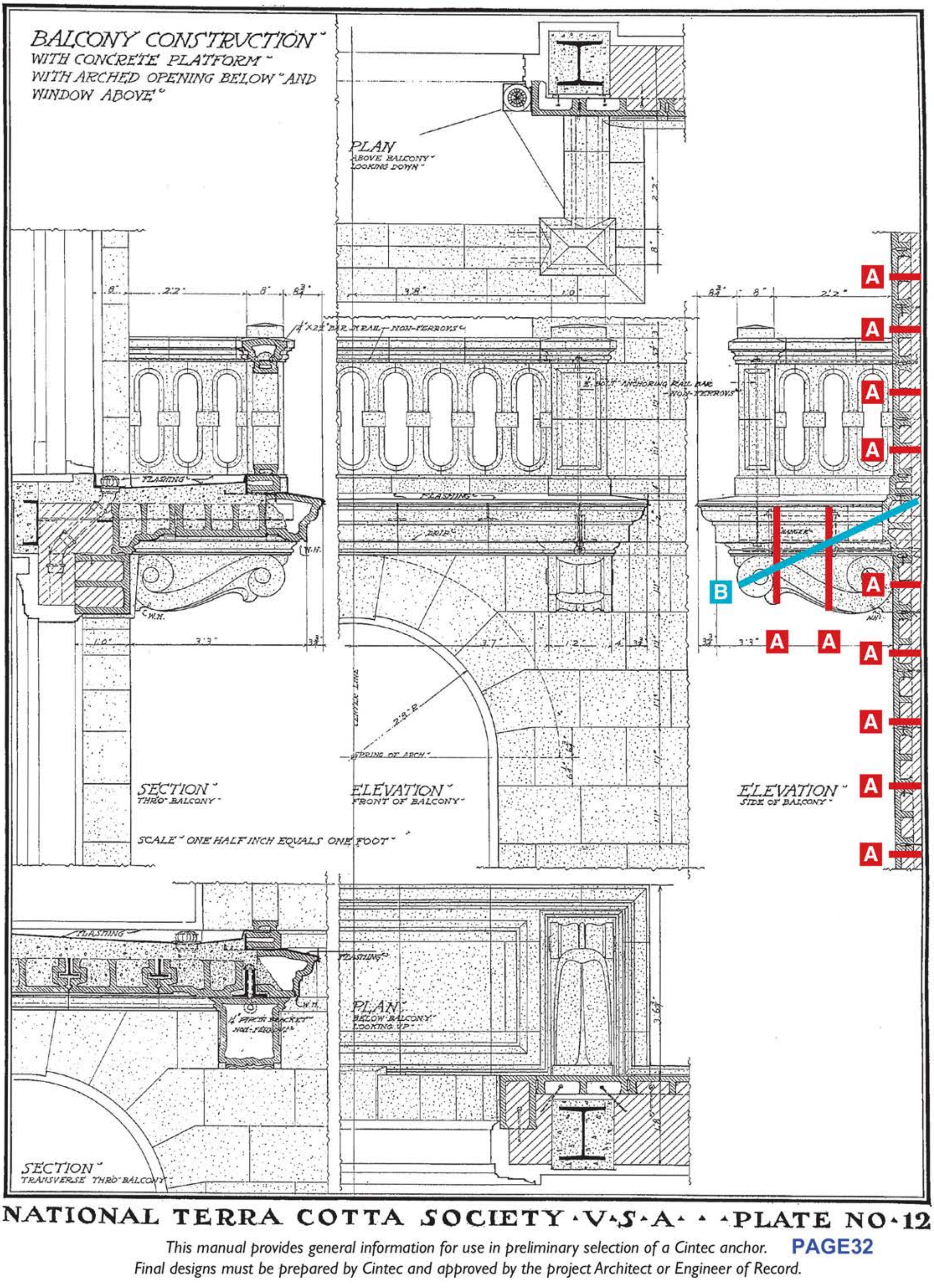
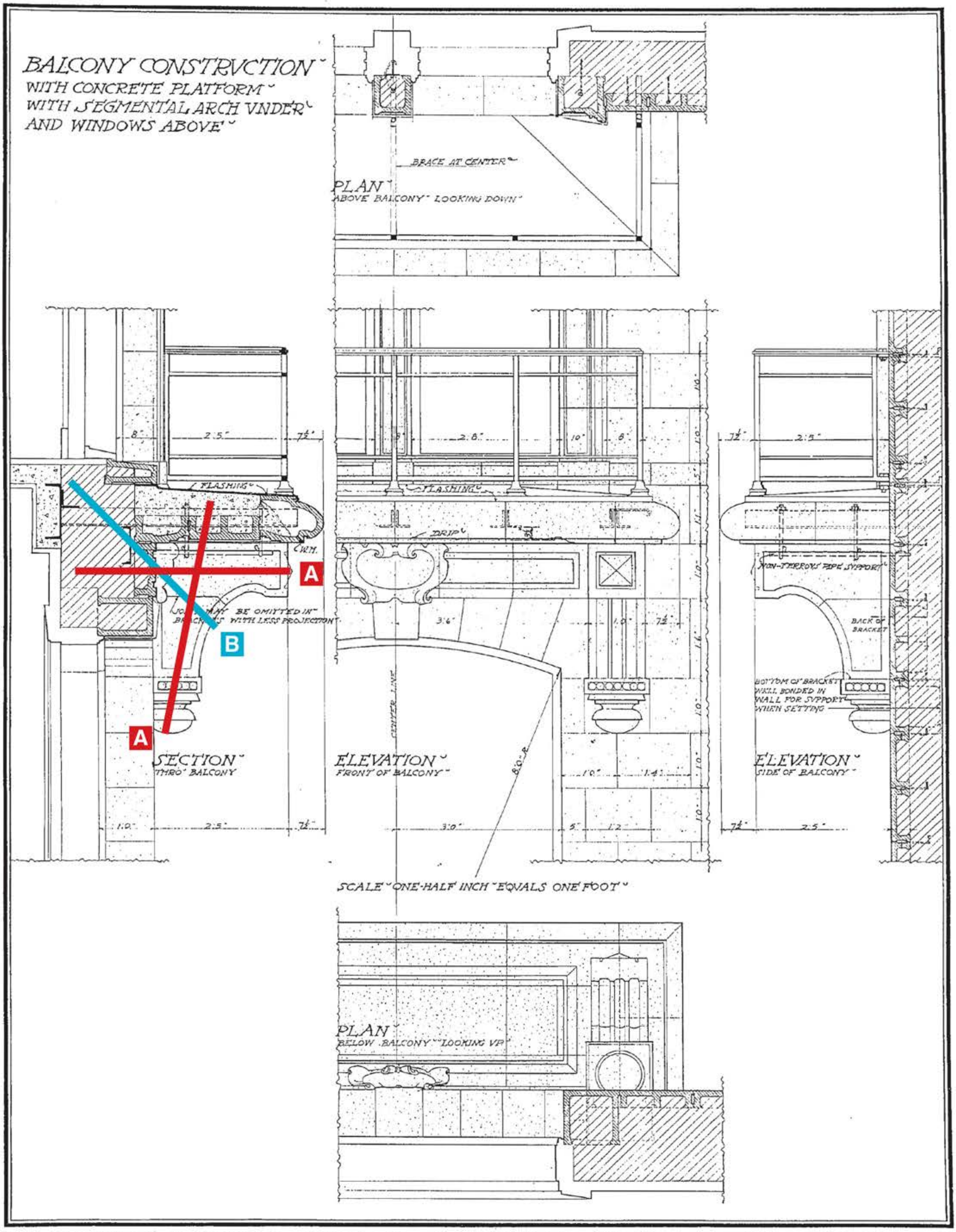
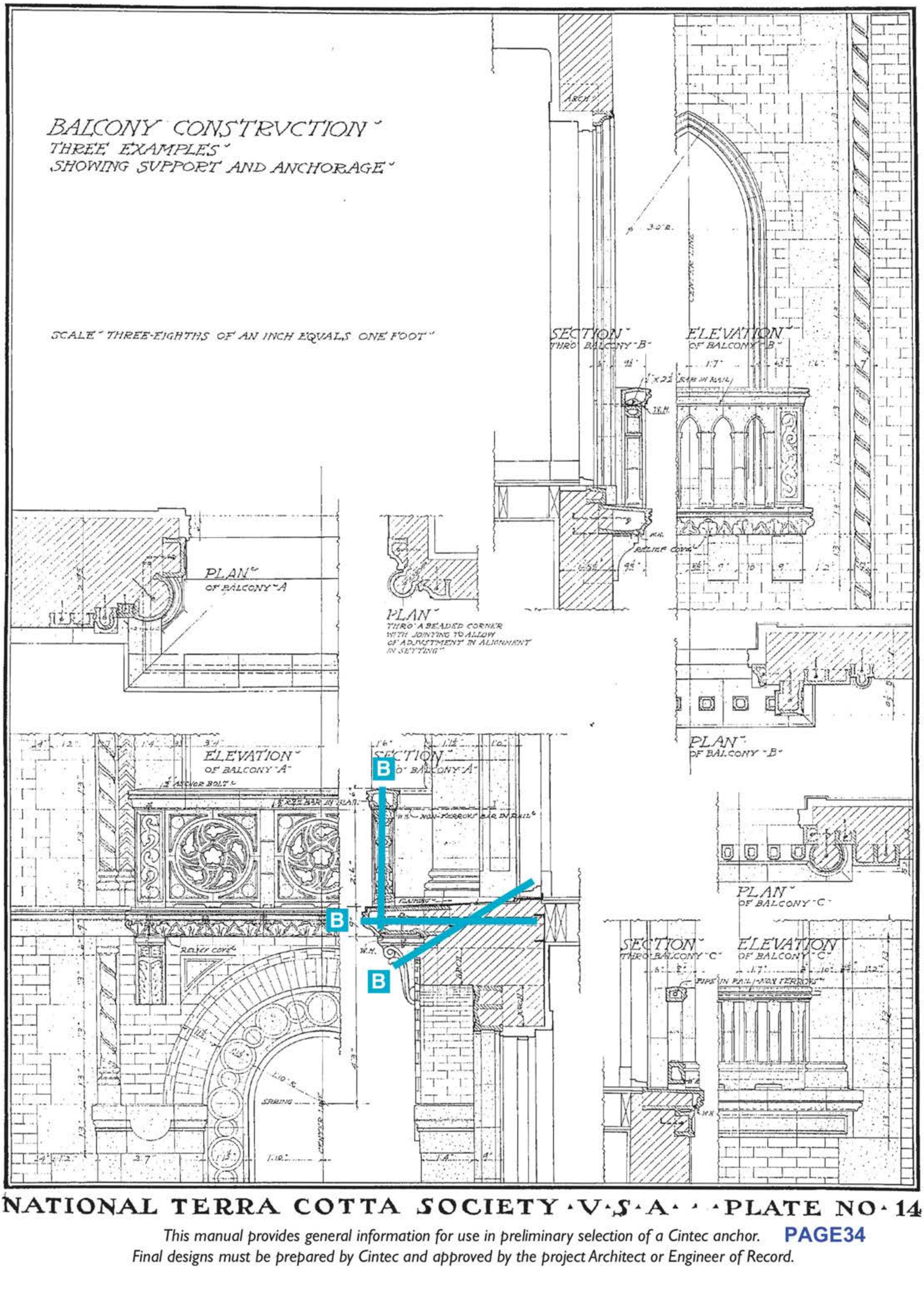
TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U·S·A · · PLATE NO · 12


BALCONY CONSTRUCTION
WITH CONCRETE PLATFORM
WITH SEGMENTAL ARCH UNDER
AND WINDOWS ABOVE
BRACE AT CENTER
PLAN
ABOVE BALCONY · LOOKING DOWN
FLASHING
DRIP
W.M.
NON-FERROUS PIPE SUPPORT
BACK OF BRACKET
BOTTOM OF BRACKET WELL BONDED IN WALL FOR SUPPORT WHEN SETTING
A
B
SECTION
THRO' BALCONY
ELEVATION
FRONT OF BALCONY
ELEVATION
SIDE OF BALCONY
CENTER LINE
SCALE · ONE-HALF INCH · EQUALS ONE FOOT
PLAN
BELOW BALCONY · LOOKING UP



This manual provides general information for use in preliminary selection of a Cintec anchor. **PAGE34**
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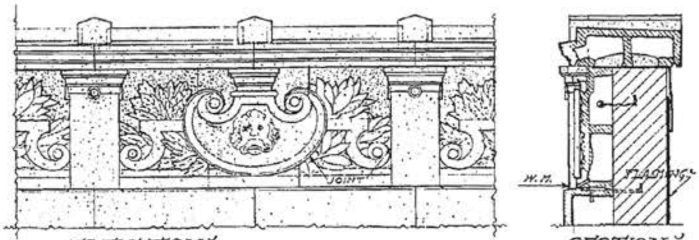
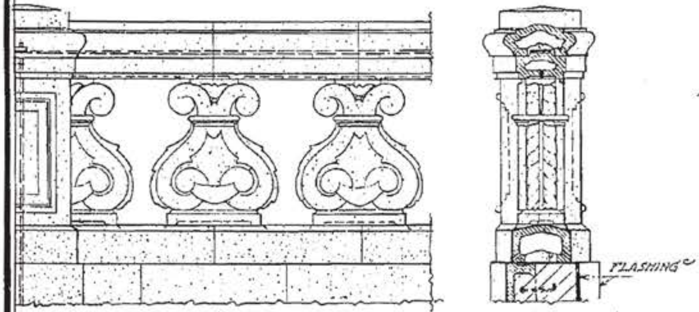
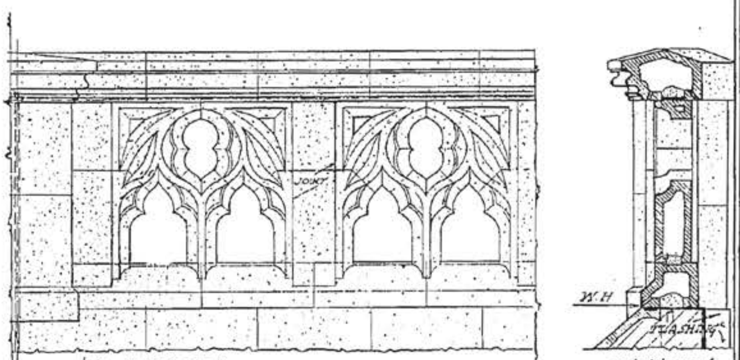
BALUSTRADES & PARAPETS



ELEVATION   SECTION

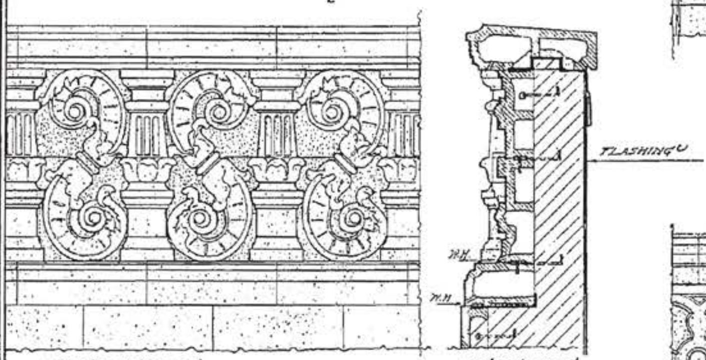


ELEVATION   SECTION



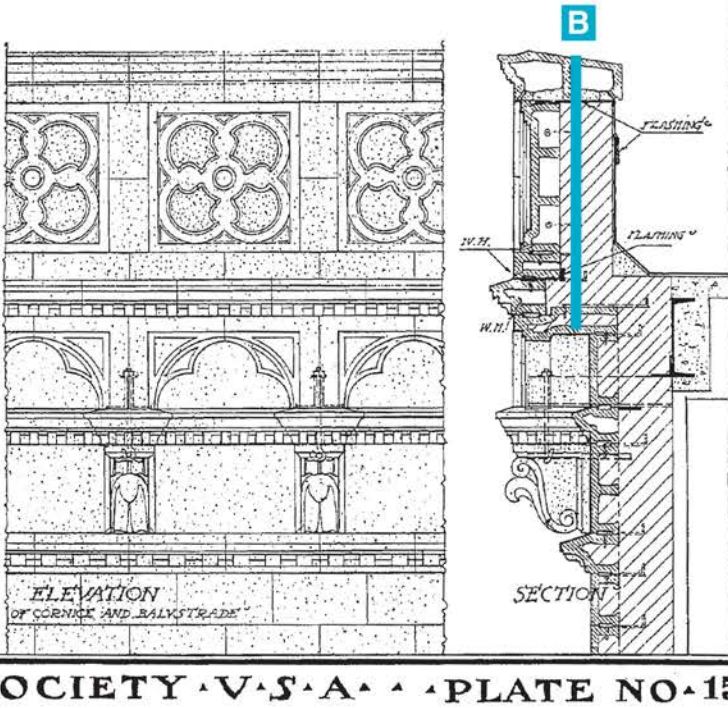
ELEVATION   SECTION

SCALE ONE-HALF INCH EQUALS ONE FOOT



ELEVATION   SECTION

IN BALUSTRADES WITH SOLID BACKS THE USE OF DARK COLORS IN THE FIELD OF PANELS WILL GIVE THE APPEARANCE OF PERFORATED WORK



ELEVATION OF CORNICE AND BALUSTRADE   SECTION

This manual provides general information for use in preliminary selection of a Cintec anchor. **PAGE35**
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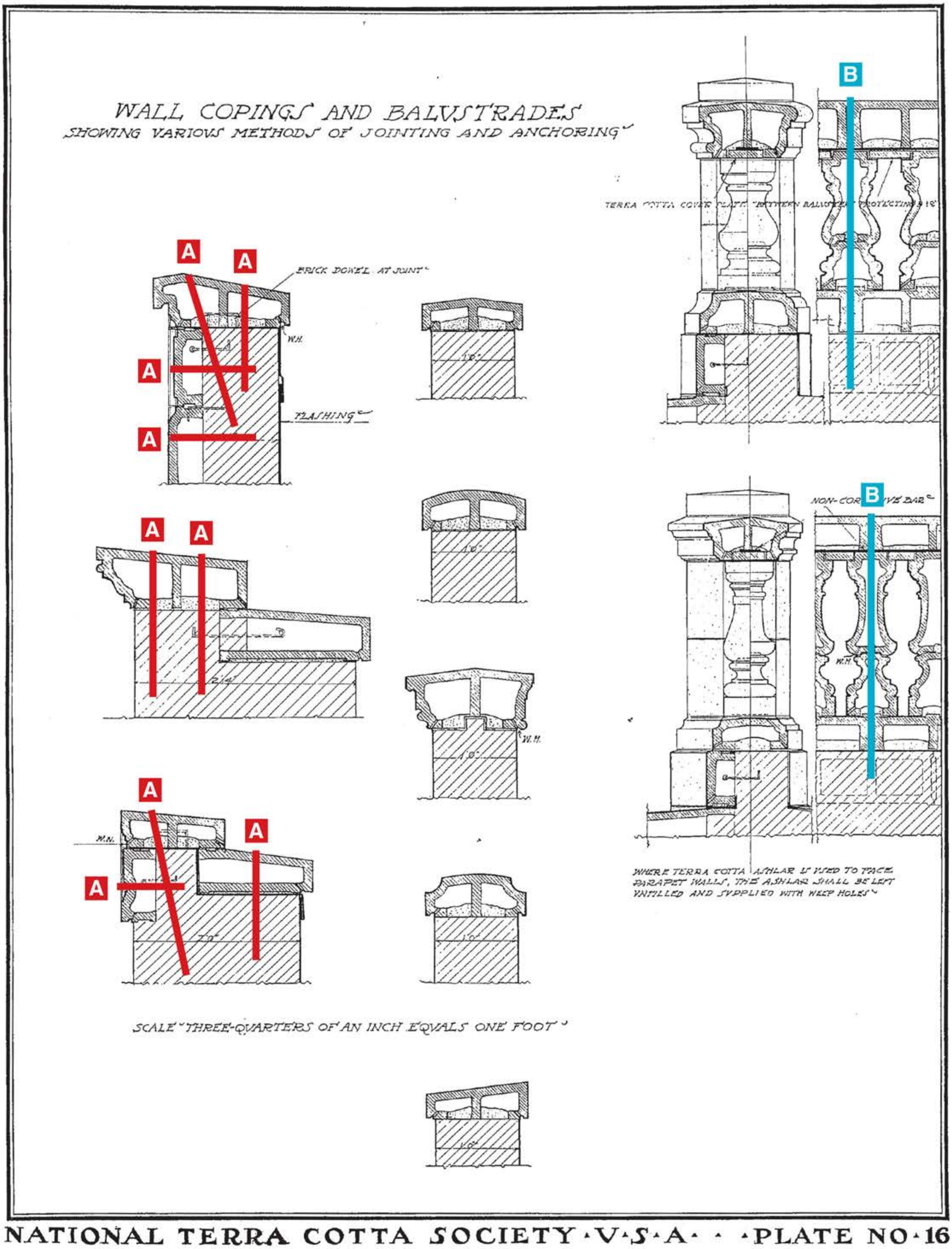
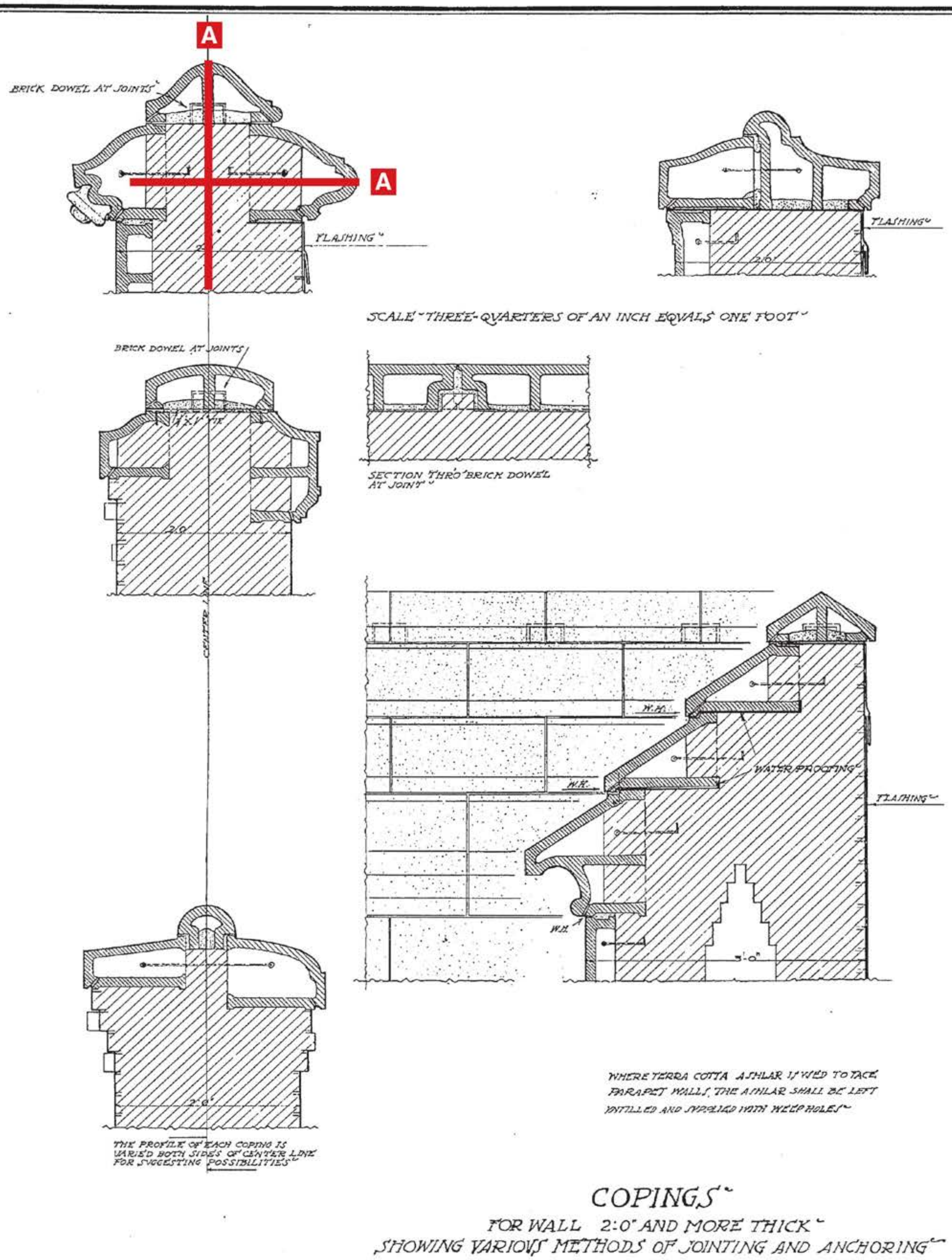
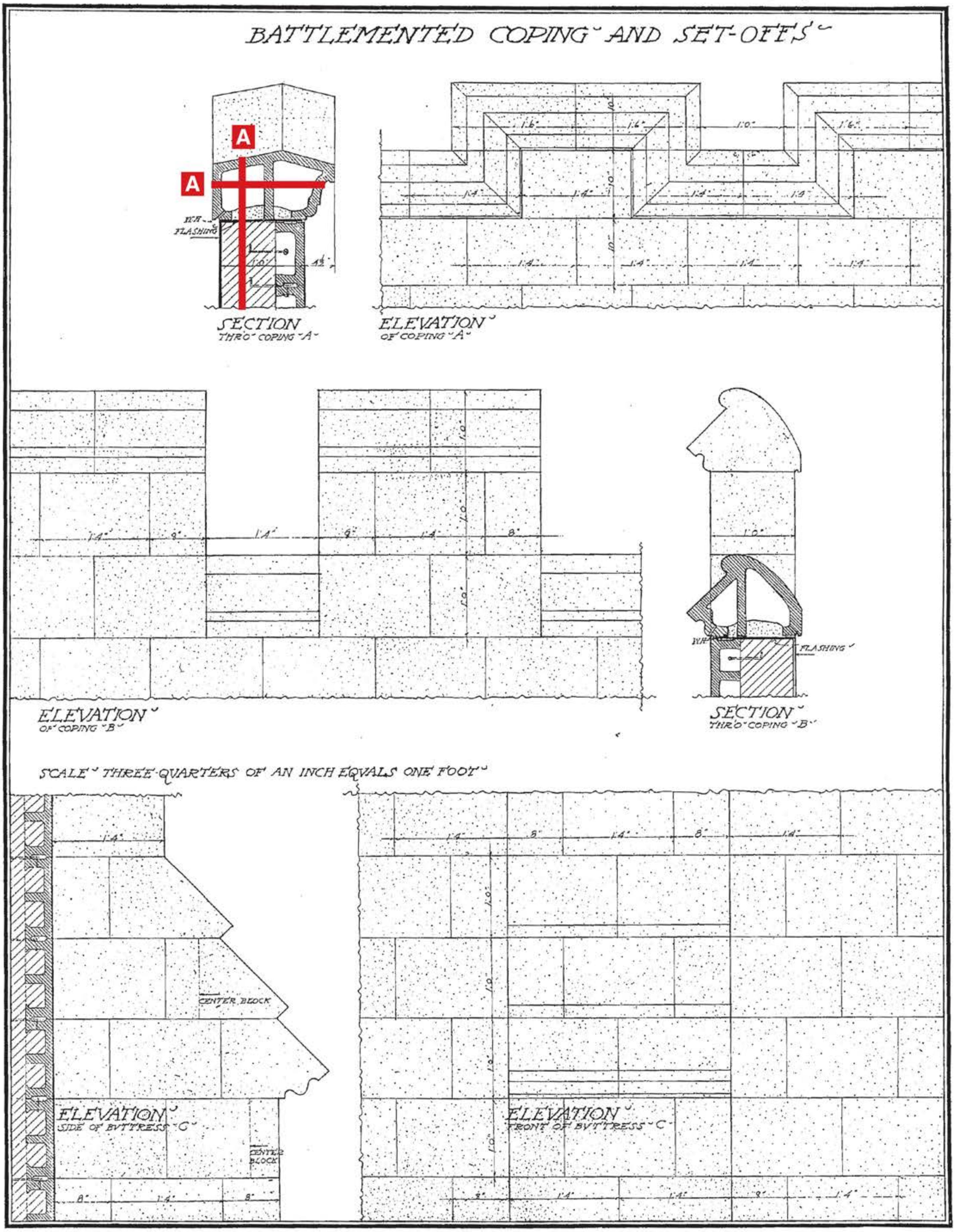

WALL COPINGS AND BALUSTRADES
SHOWING VARIOUS METHODS OF JOINTING AND ANCHORING
BRICK DOWEL AT JOINT
W.H.
FLASHING
A
B
WHERE TERRA COTTA ASHLAR IS USED TO FACE PARAPET WALLS, THE ASHLAR SHALL BE LEFT UNFILLED AND SUPPLIED WITH WEEP HOLES
SCALE THREE-QUARTERS OF AN INCH EQUALS ONE FOOT



COPINGS

FOR WALL 2:0" AND MORE THICK

SHOWING VARIOUS METHODS OF JOINTING AND ANCHORING



This manual provides general information for use in preliminary selection of a Cintec anchor. **PAGE38**
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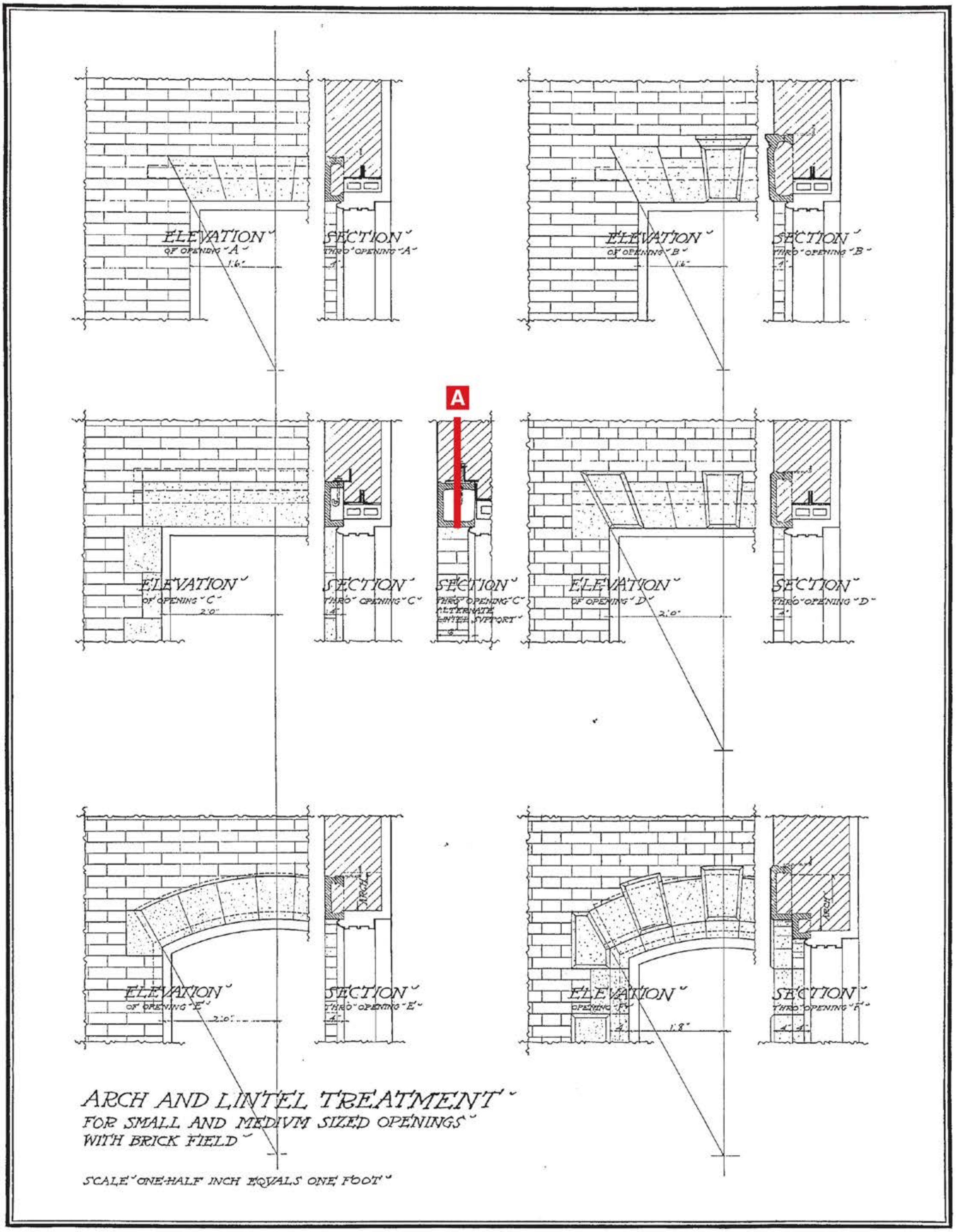

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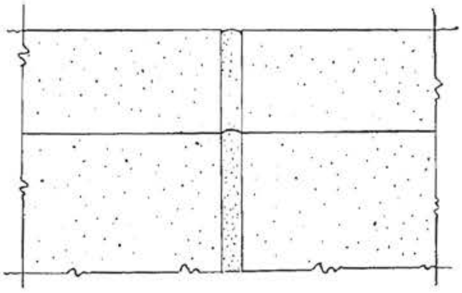
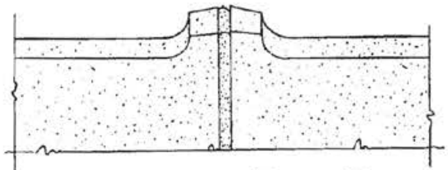
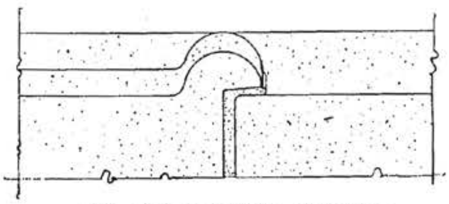


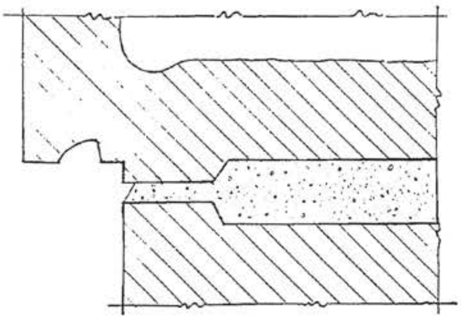
"STANDARD FLUSH JOINT" RECOMMENDED AS SUPERIOR TO THE OLD STYLE RAISED AND ROLL JOINTS SHOWN BELOW



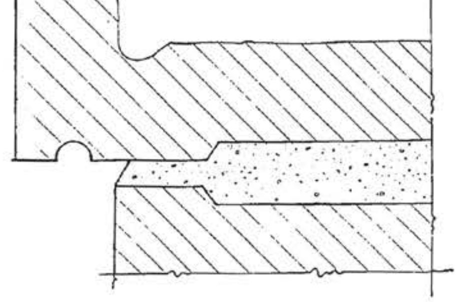
OLD STYLE RAISED JOINT



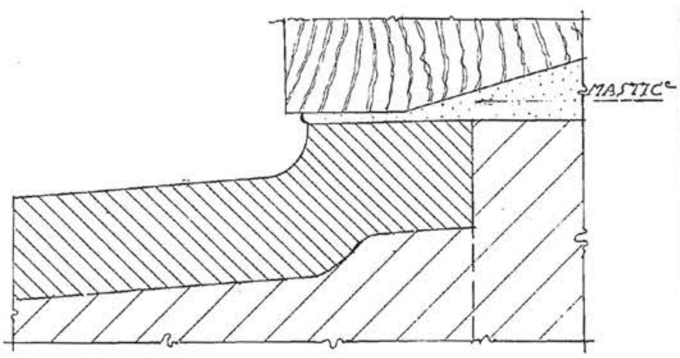
OLD STYLE ROLL JOINT



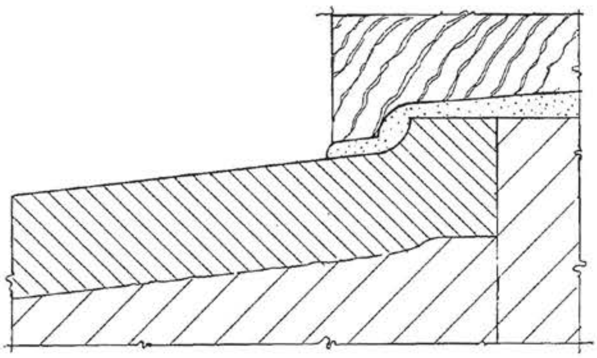
TYPICAL DRIP DETAILS



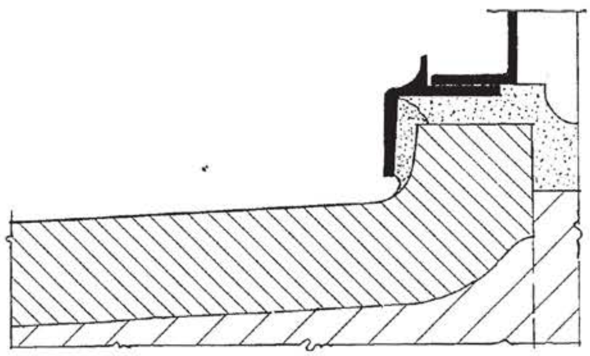
SCALE HALF AND QUARTER FULL SIZE



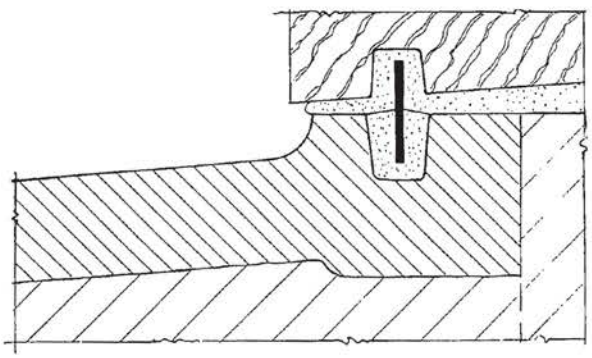
WOOD OR HOLLOW METAL SILLS



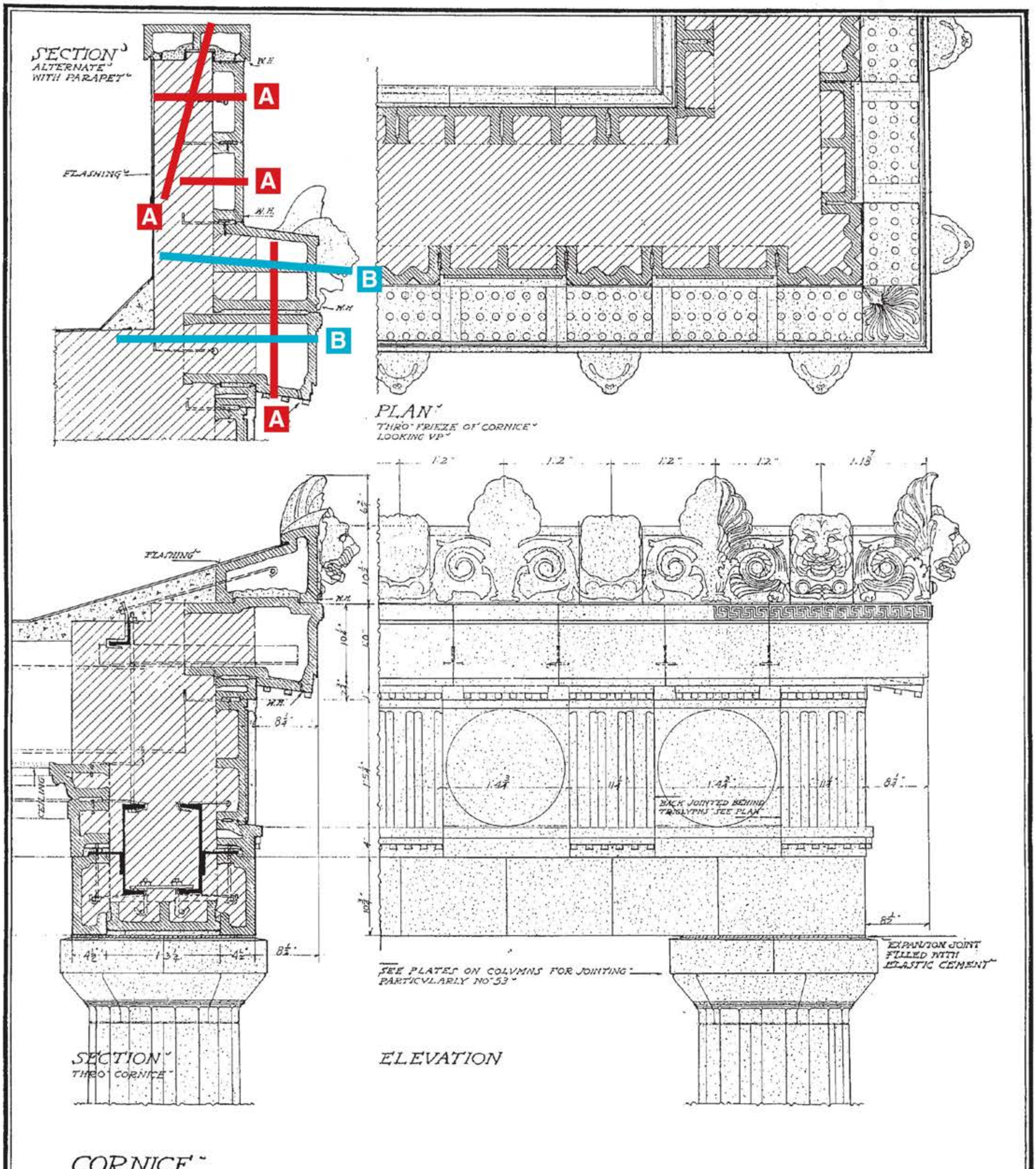
TUCK UNDER SILL



SILL FOR SOLID METAL FRAMES

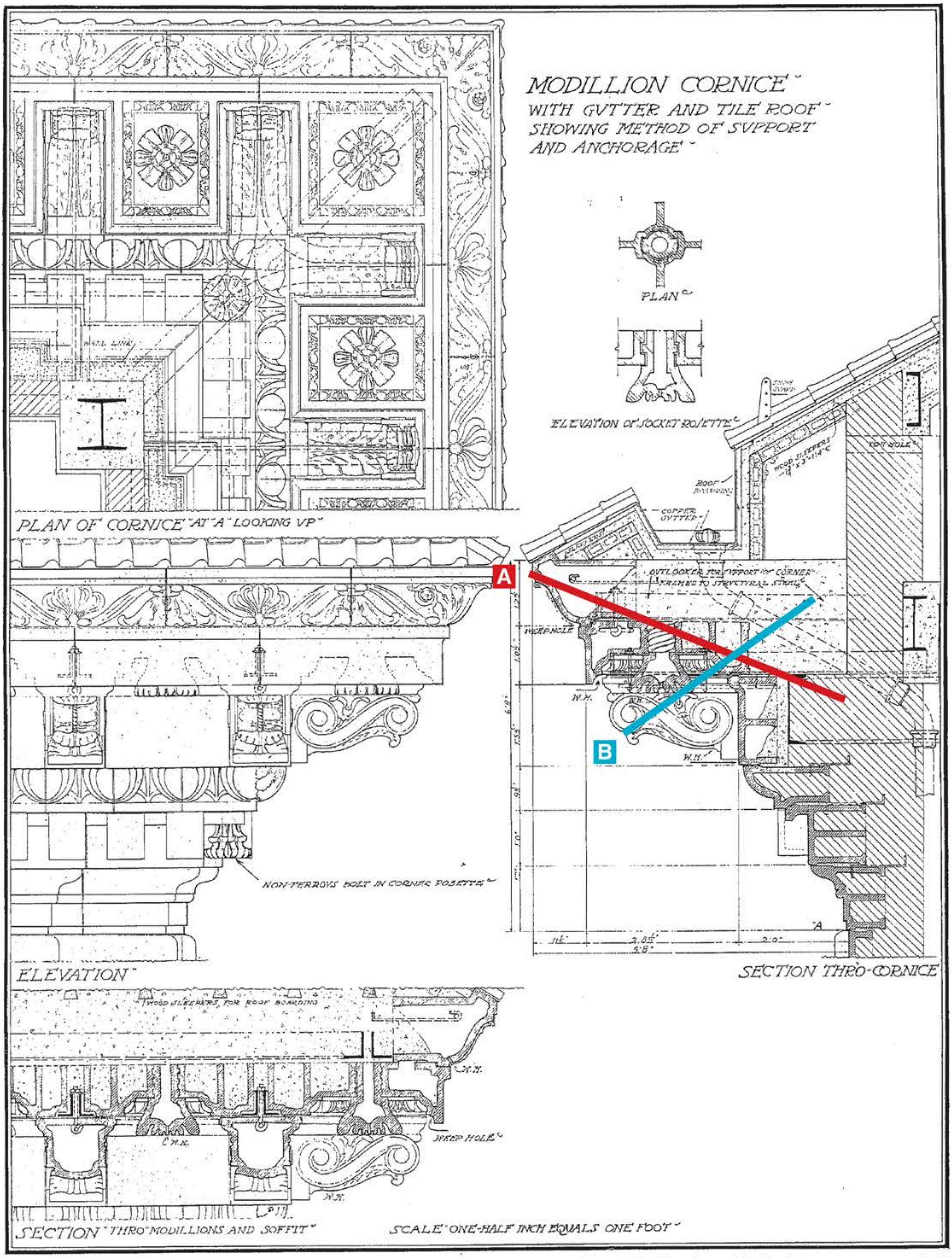


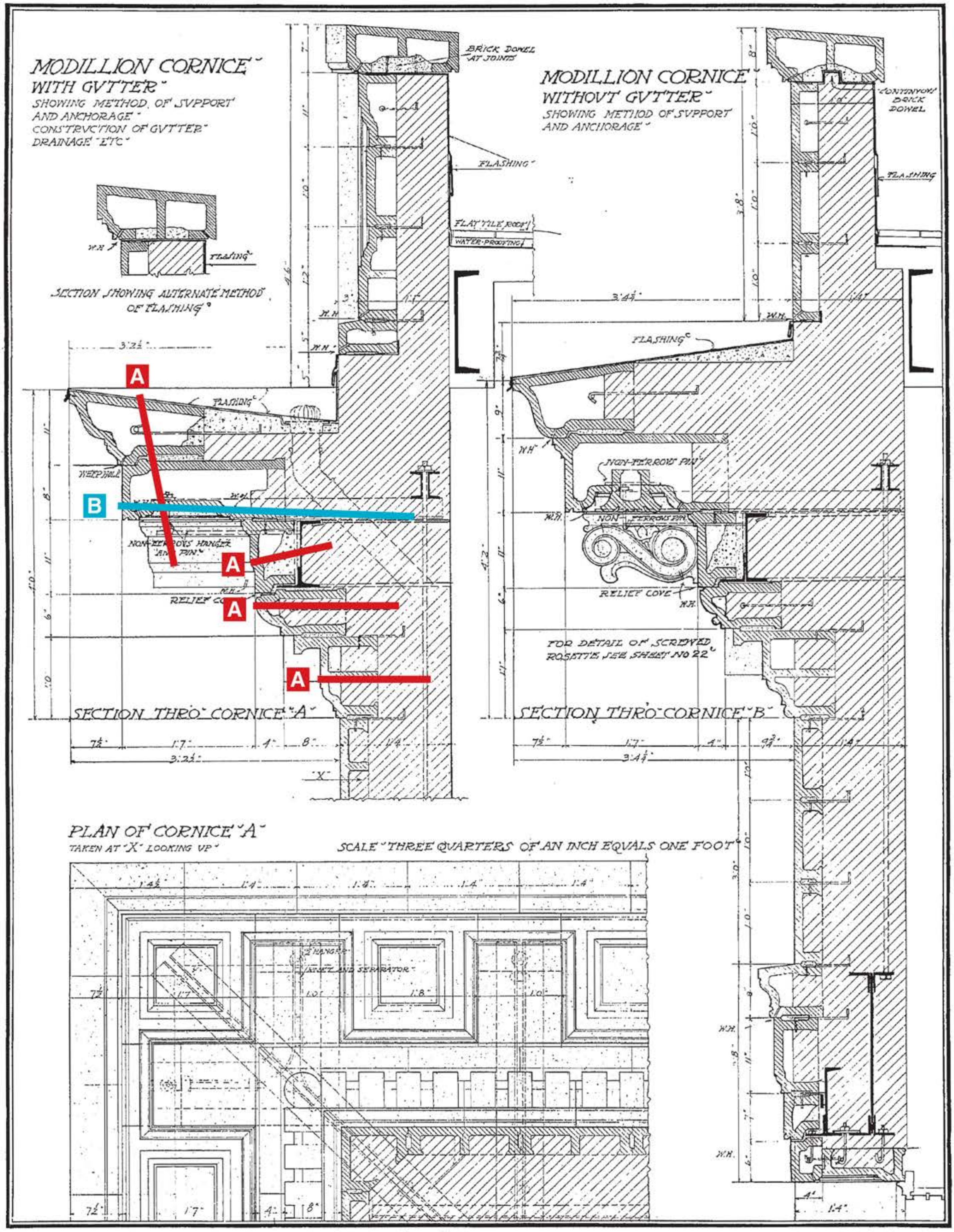
SILL WITH NON-FERROUS WATER BAR

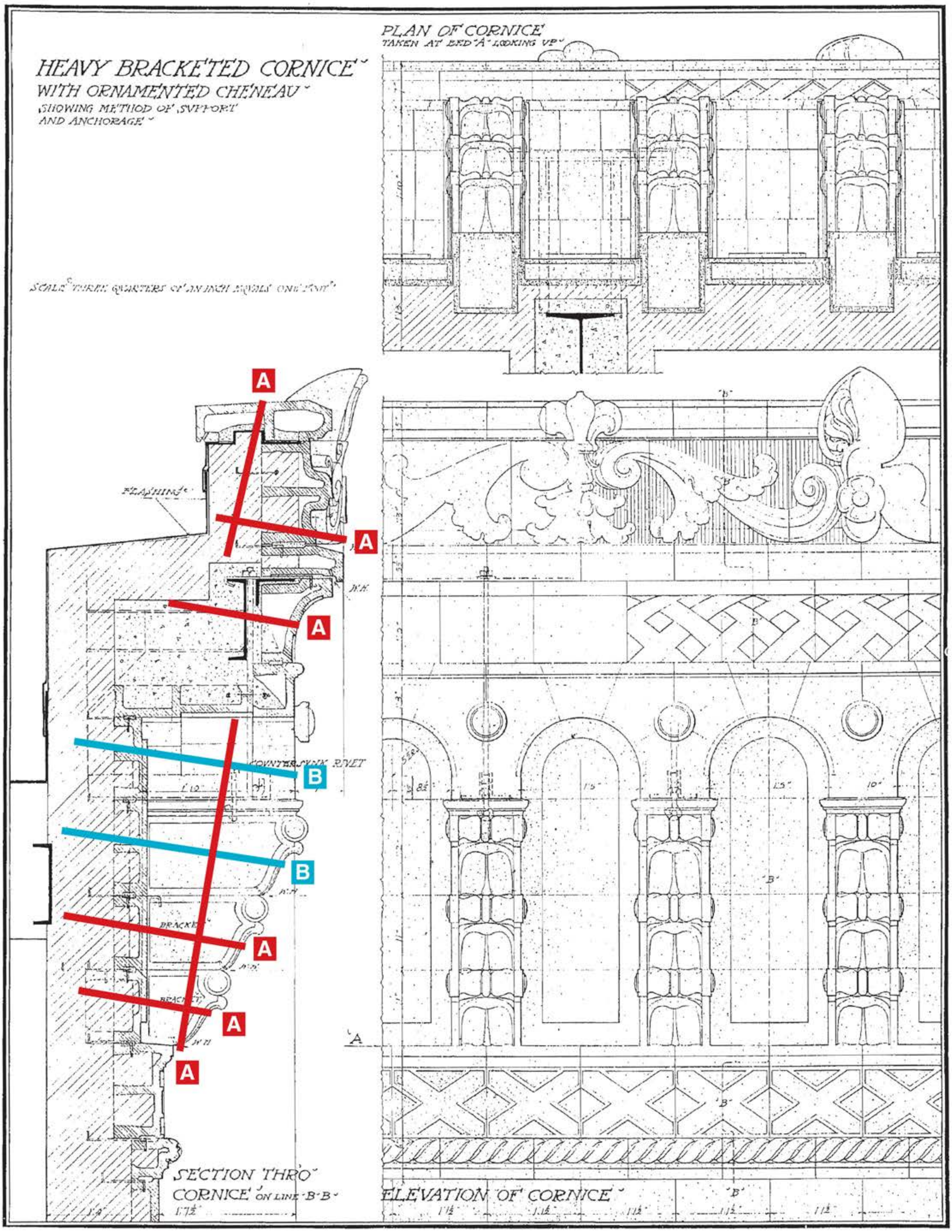


CORNICE
WITH CHENEAV · PANELED SOFFIT · ETC
SHOWING METHOD OF SVPPORT AND ANCHORAGE

SCALE · THREE-QUARTERS OF AN INCH EQUALS ONE FOOT


MODILLION CORNICE
WITH GUTTER AND TILE ROOF
SHOWING METHOD OF SUPPORT
AND ANCHORAGE
PLAN
ELEVATION OF SOCKET ROSETTE
PLAN OF CORNICE AT "A" LOOKING UP
WALL LINE
COPPER GUTTER
ROOF BOARDING
WOOD SLEEPERS
OUTLOOKER FOR SUPPORT OF CORNER FRAMED TO STRUCTURAL STEEL
WEEP HOLE
A
B
NON-FERROUS BOLT IN CORNER ROSETTE
ELEVATION
SECTION THRO CORNICE
WOOD SLEEPERS FOR ROOF BOARDING
WEEP HOLE
SECTION THRO MODILLIONS AND SOFFIT
SCALE ONE-HALF INCH EQUALS ONE FOOT


MODILLION CORNICE WITH GVTTER
SHOWING METHOD OF SVPPORT AND ANCHORAGE CONSTRVCTION OF GVTTER DRAINAGE ETC
SECTION SHOWING ALTERNATE METHOD OF FLASHING
MODILLION CORNICE WITHOVT GVTTER
SHOWING METHOD OF SVPPORT AND ANCHORAGE
BRICK DOWEL AT JOINTS
FLASHING
FLAT TILE ROOF
WATER-PROOFING
CONTINUOUS BRICK DOWEL
WEEP HOLE
NON-FERROUS HANGER AND PIN
NON-FERROUS PIN
RELIEF COVE
FOR DETAIL OF SCREWED ROSETTE SEE SHEET NO 22
SECTION THRO CORNICE "A"
SECTION THRO CORNICE "B"
PLAN OF CORNICE "A"
TAKEN AT "X" LOOKING UP
SCALE THREE QUARTERS OF AN INCH EQUALS ONE FOOT
HANGER
ANGLE AND SEPARATOR
A
B



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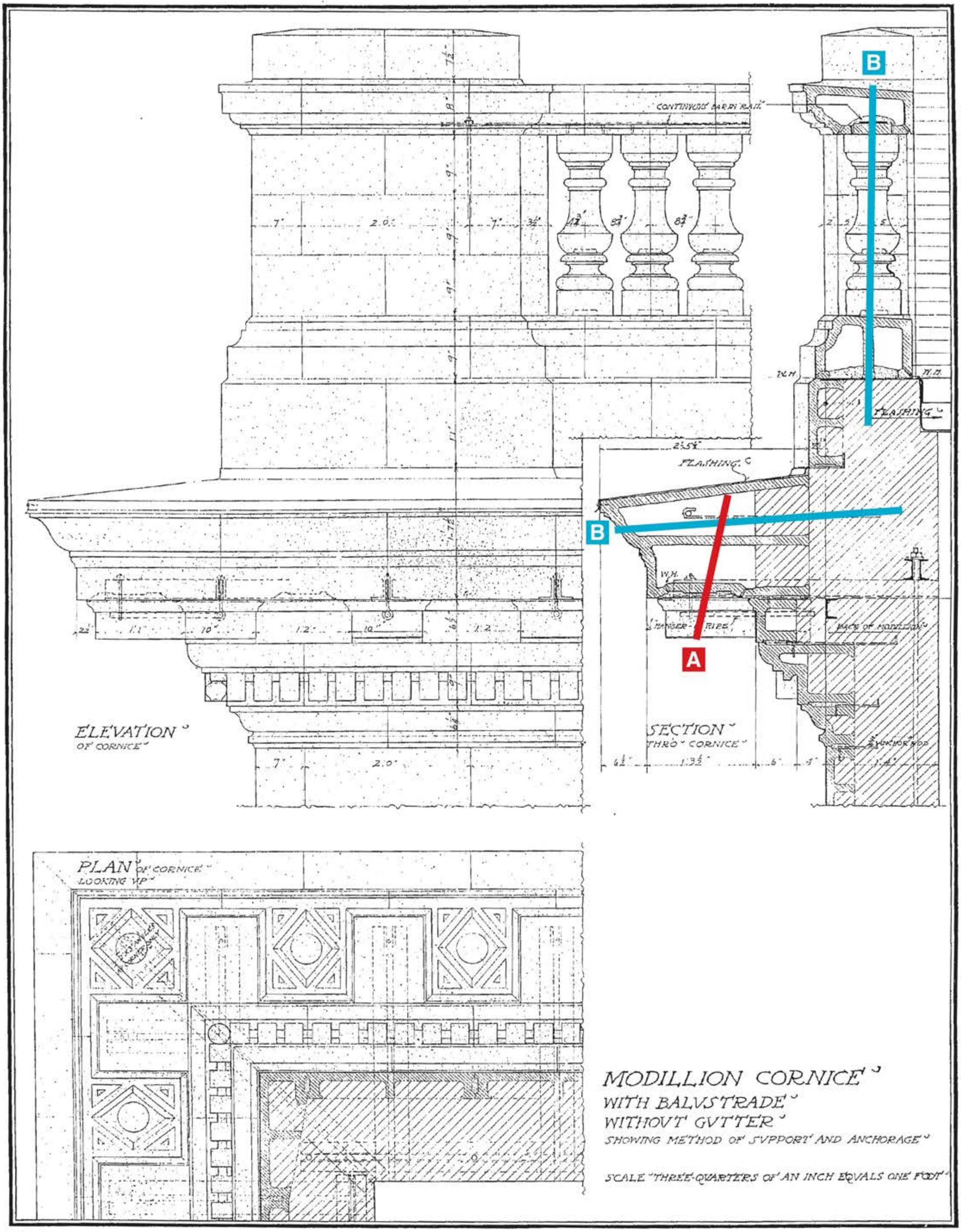
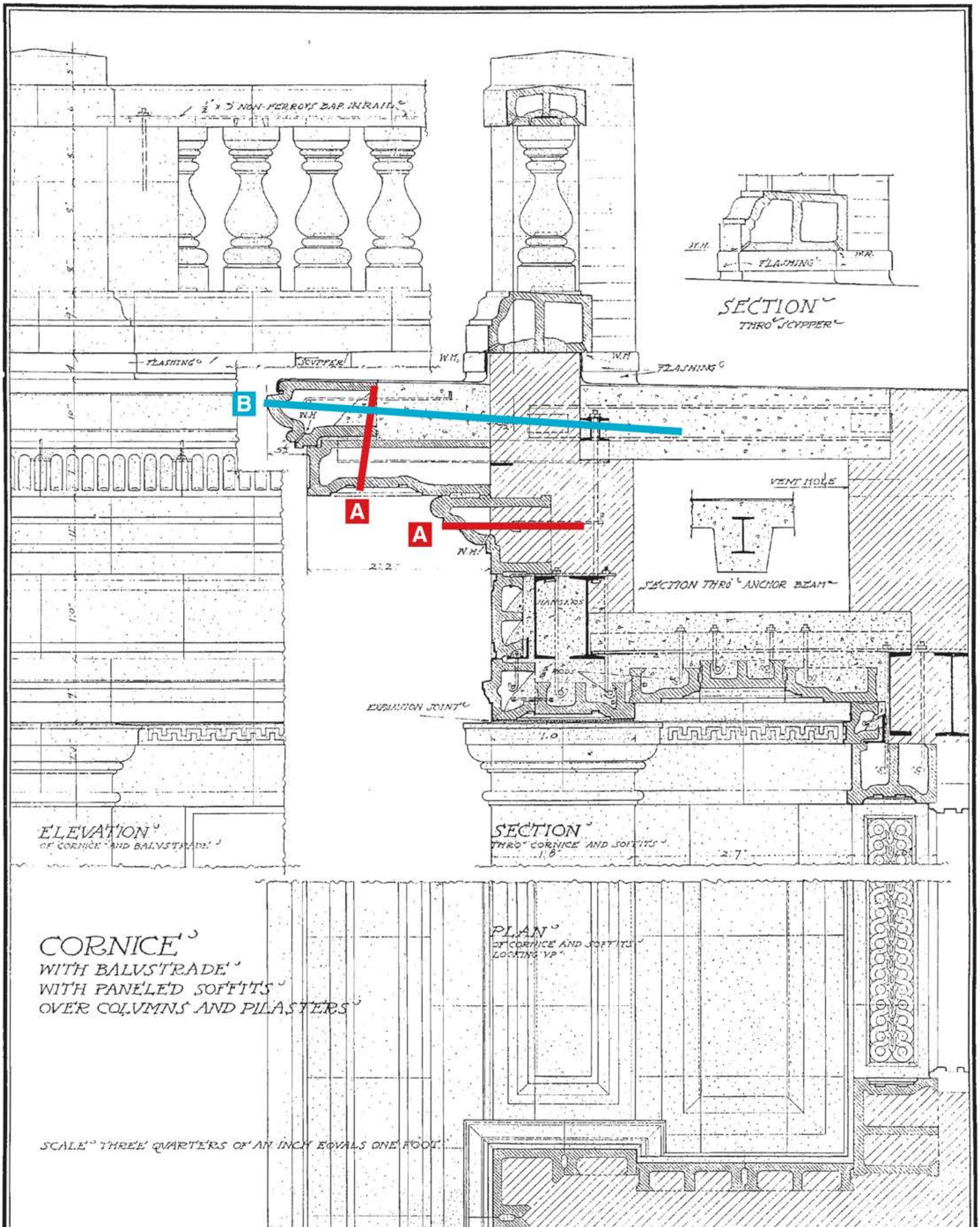


NATIONAL TERRA COTTA SOCIETY · U · S · A · · · PLATE NO · 25



This manual provides general information for use in preliminary selection of a Cintec anchor. **PAGE46**
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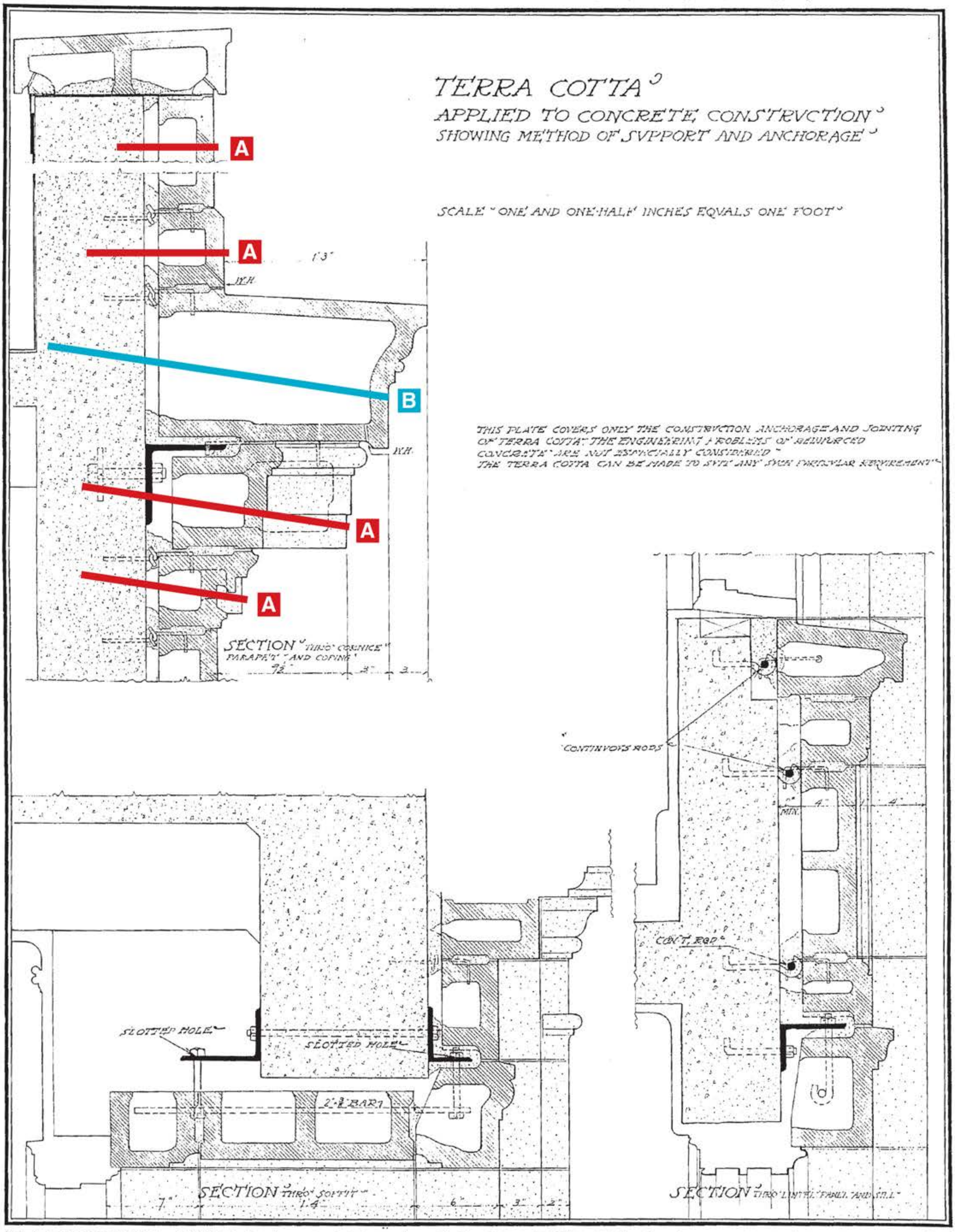
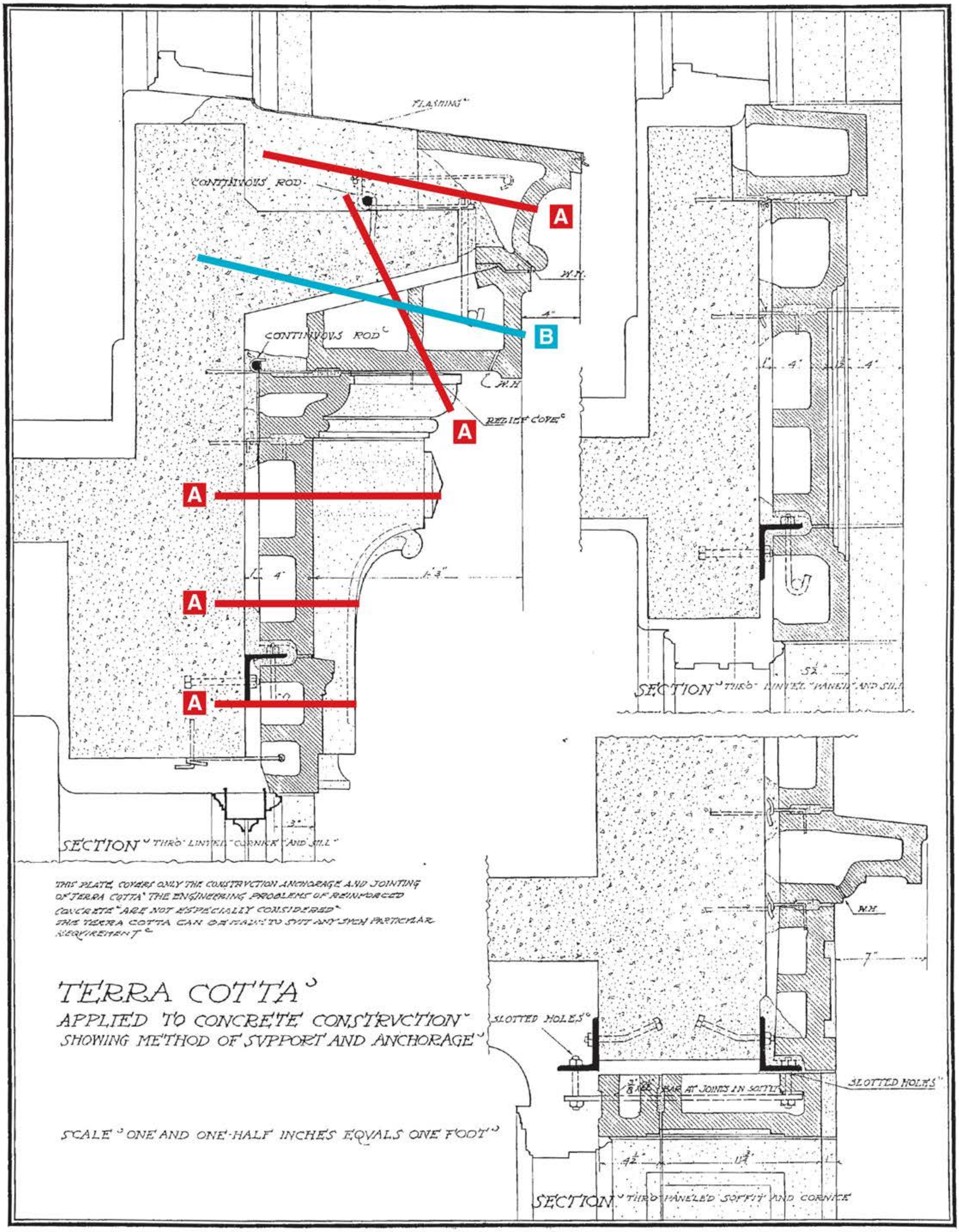

TERRA COTTA
APPLIED TO CONCRETE CONSTRUCTION
SHOWING METHOD OF SUPPORT AND ANCHORAGE
SCALE "ONE AND ONE-HALF INCHES EQUALS ONE FOOT"
THIS PLATE COVERS ONLY THE CONSTRUCTION ANCHORAGE AND JOINTING OF TERRA COTTA. THE ENGINEERING PROBLEMS OF REINFORCED CONCRETE ARE NOT ESPECIALLY CONSIDERED.
THE TERRA COTTA CAN BE MADE TO SUIT ANY SUCH PARTICULAR REQUIREMENT.
A
A
B
A
A
SECTION THRO' CORNICE PARAPET AND COPING
CONTINUOUS RODS
CONT. ROD
SLOTTED HOLE
SLOTTED HOLE
SECTION THRO' SOFFIT
SECTION THRO' LINTEL, PANEL AND SILL



NATIONAL TERRA COTTA SOCIETY · U · S · A · · PLATE NO · 28

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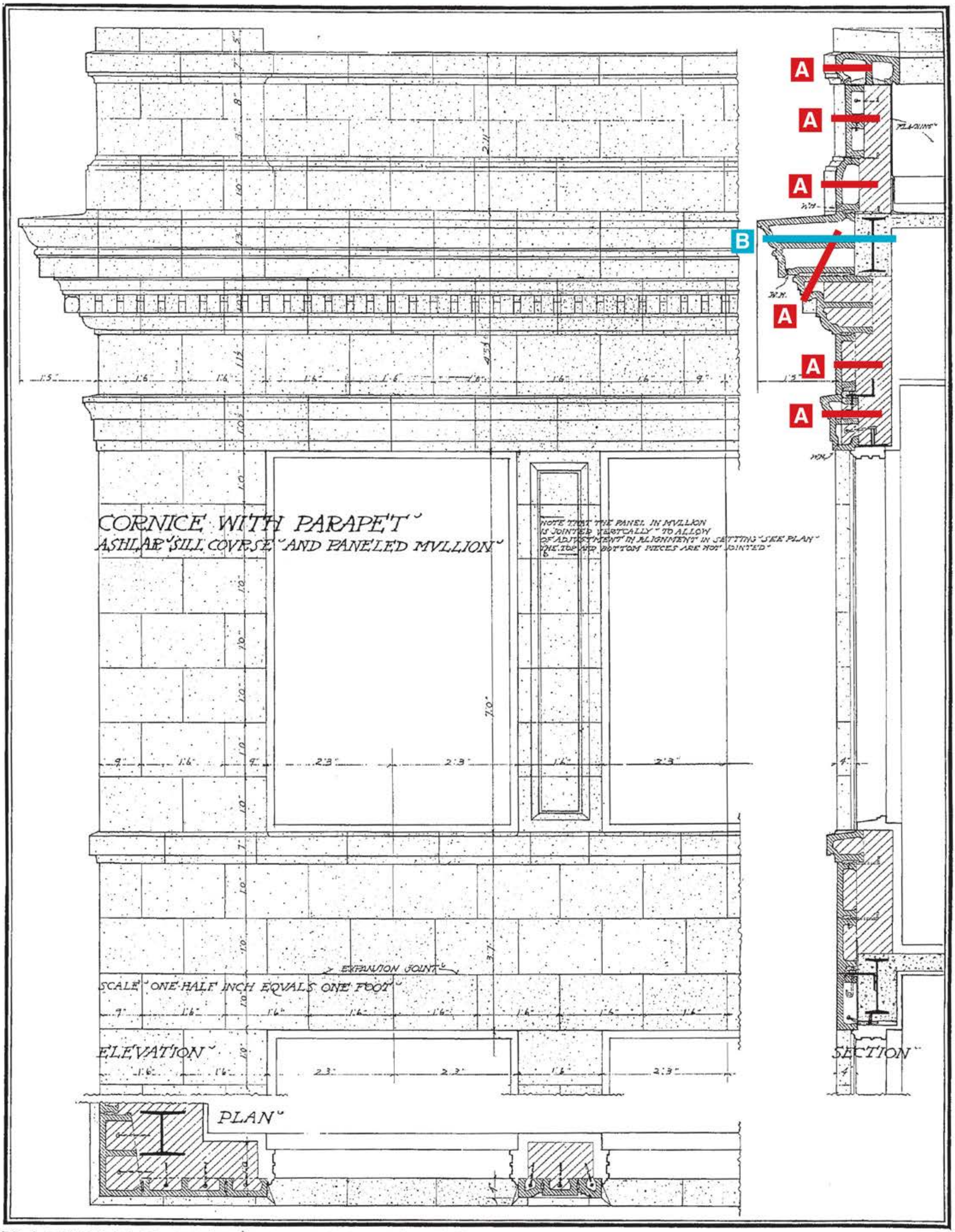
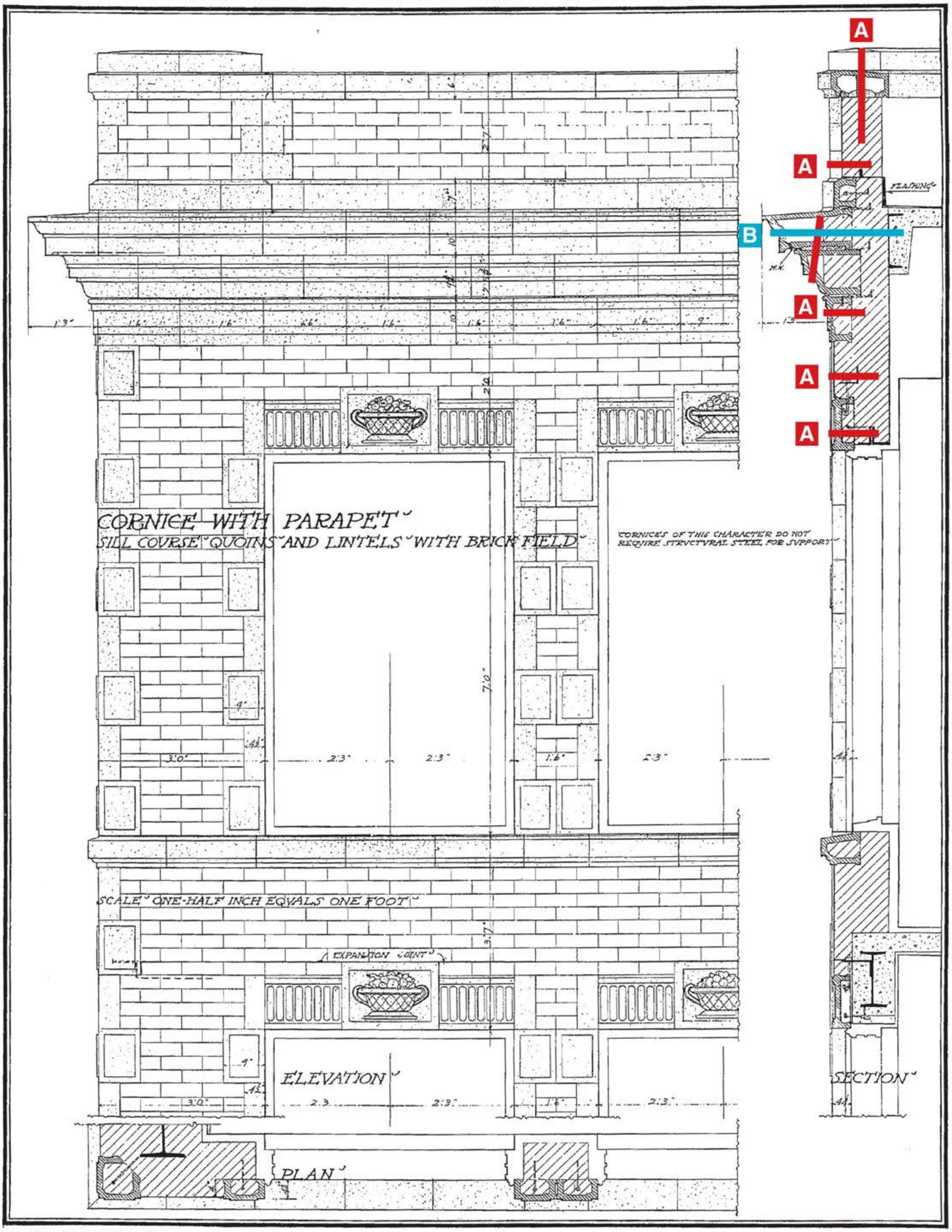


NATIONAL TERRA COTTA SOCIETY · V·S·A · · PLATE NO · 29



This manual provides general information for use in preliminary selection of a Cintec anchor. **PAGE50**
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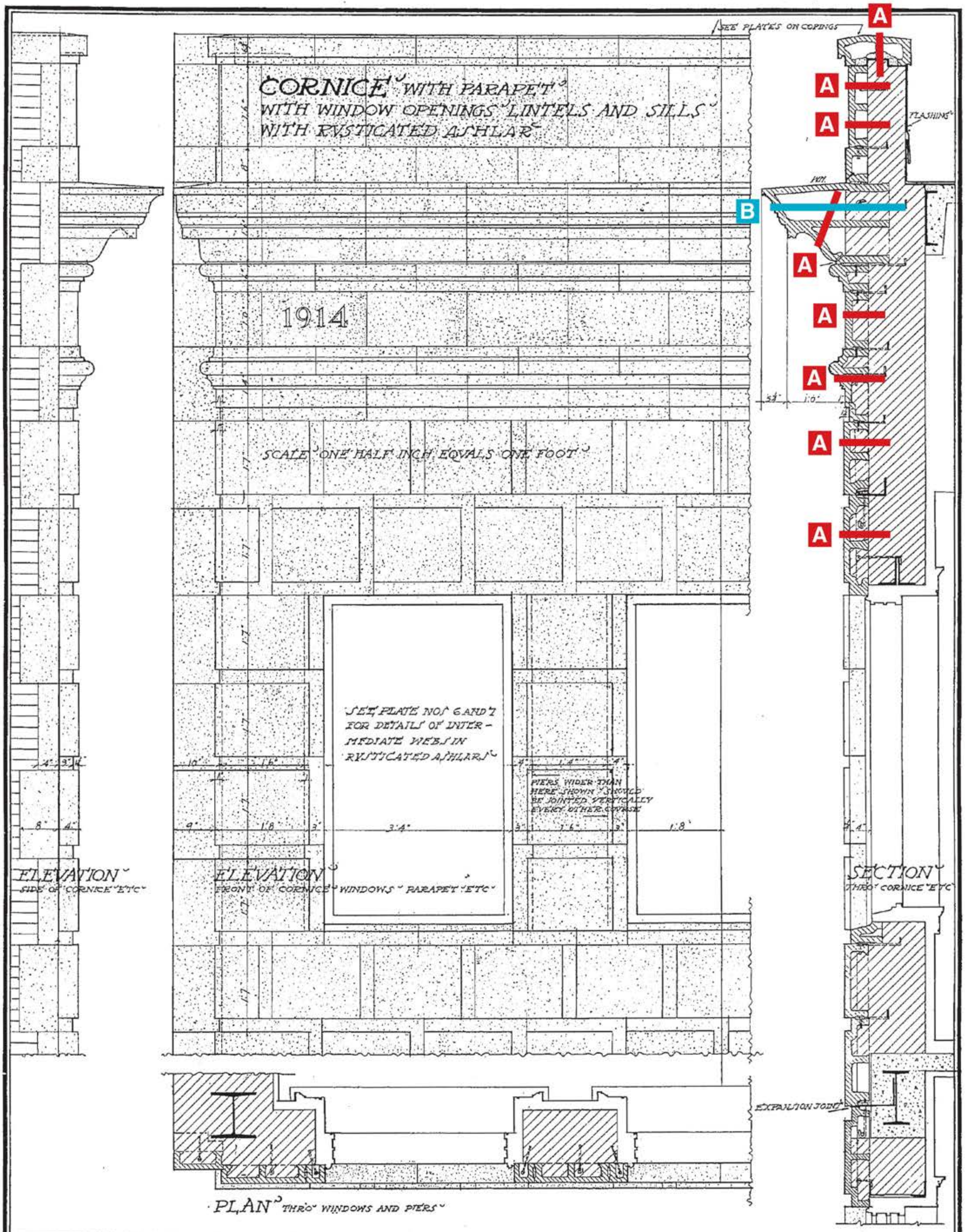
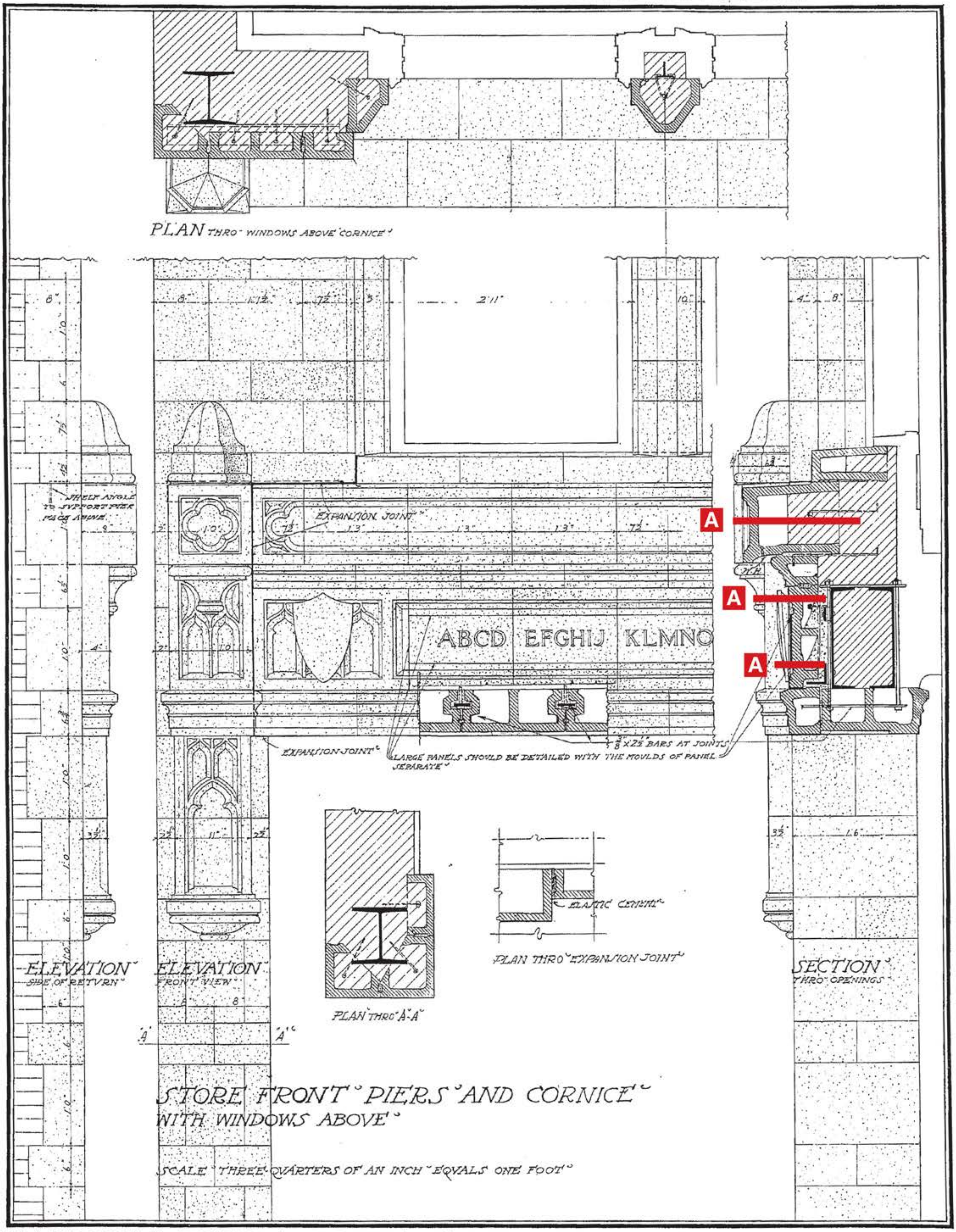


NATIONAL TERRA COTTA SOCIETY · U · S · A · · PLATE NO · 31

This manual provides general information for use in preliminary selection of a Cintec anchor. **PAGE51**

Final designs must be prepared by Cintec and approved by the project Architect or Engineer of Record.



This manual provides general information for use in preliminary selection of a Cintec anchor. **PAGE52**
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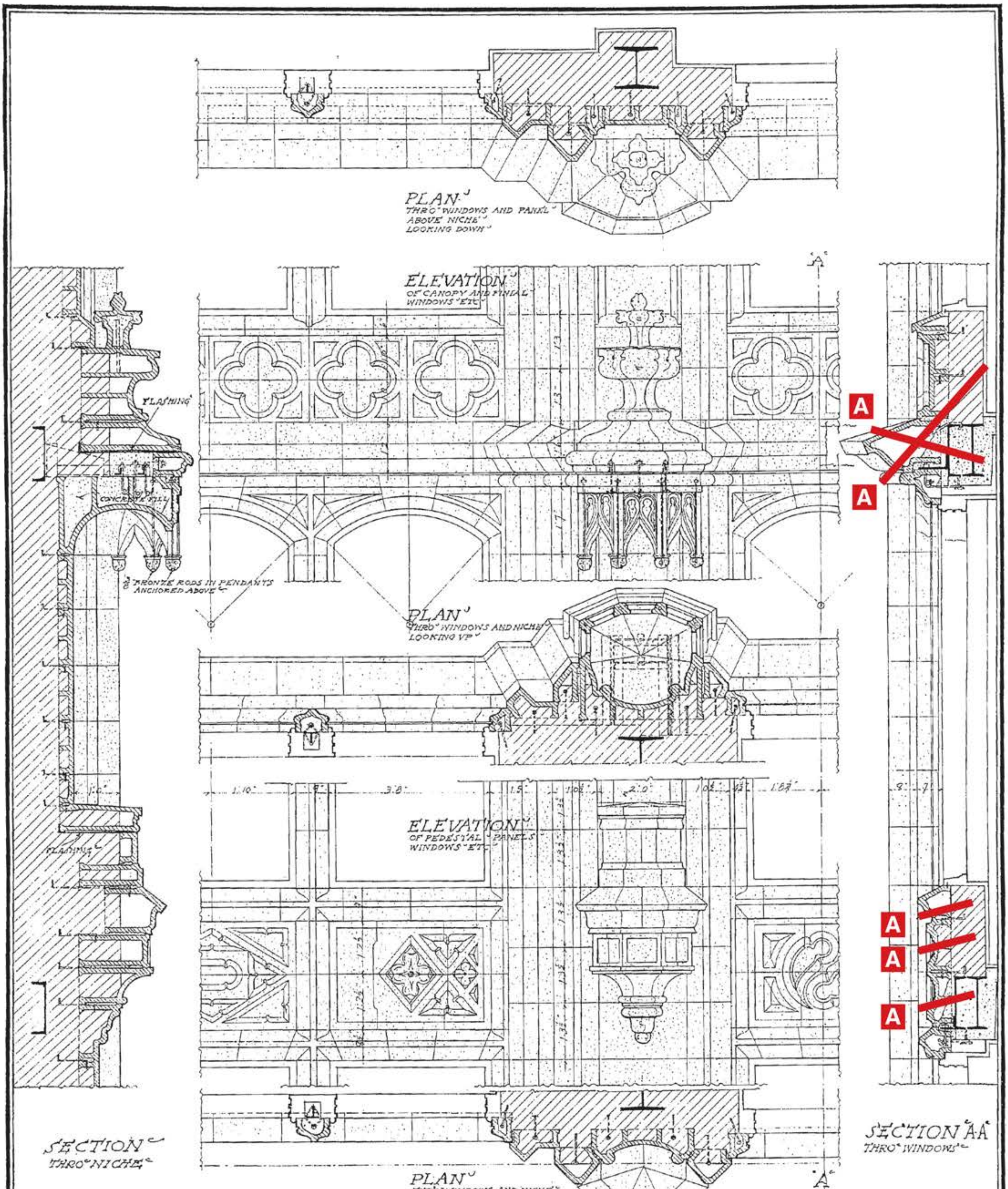
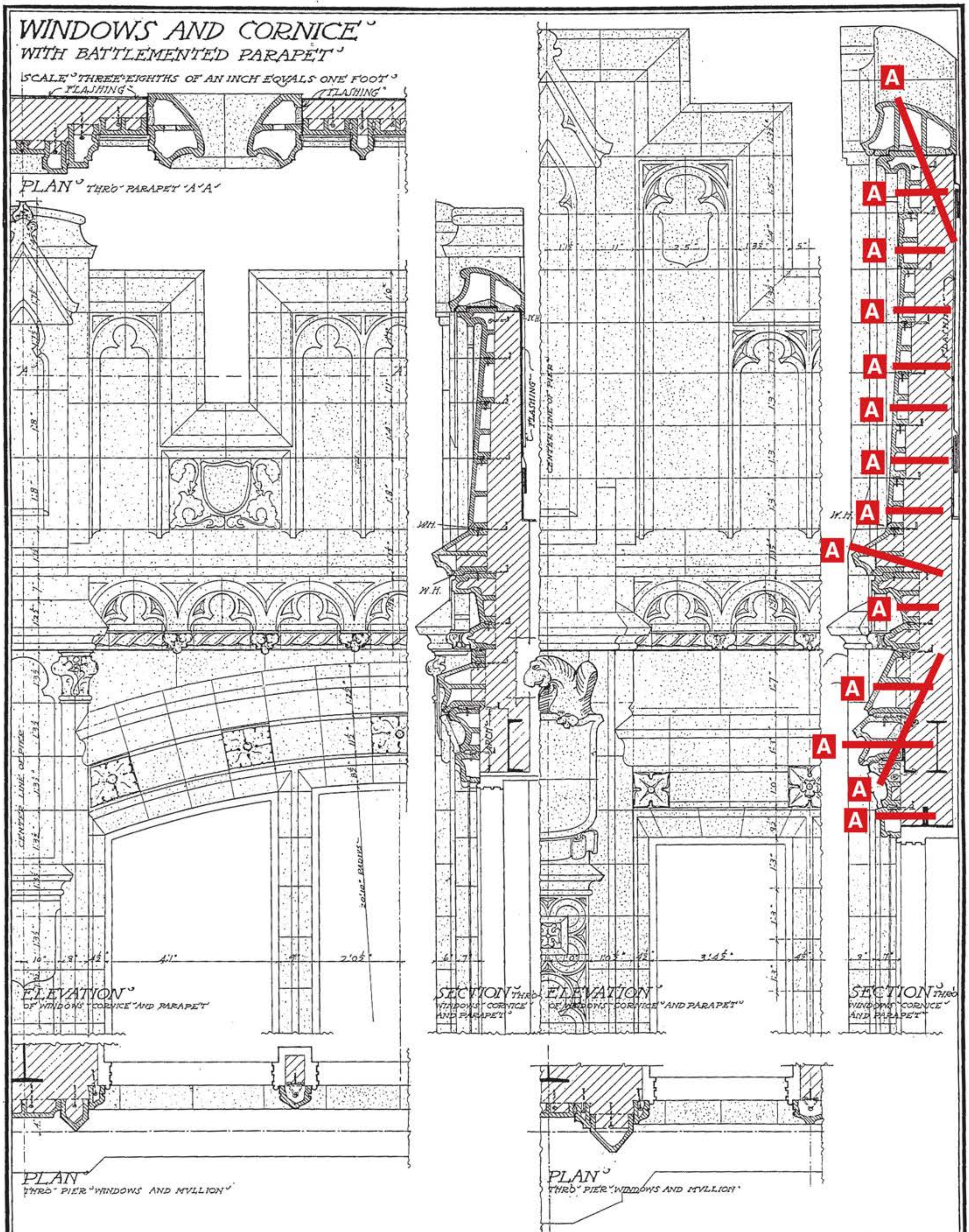


NICHE WITH PEDESTAL CANOPY AND FINIAL
WINDOWS WITH MOULDED JAMBS MULLIONS SILLS AND LINTELS

SCALE THREE-EIGHTHS OF AN INCH EQUALS ONE FOOT



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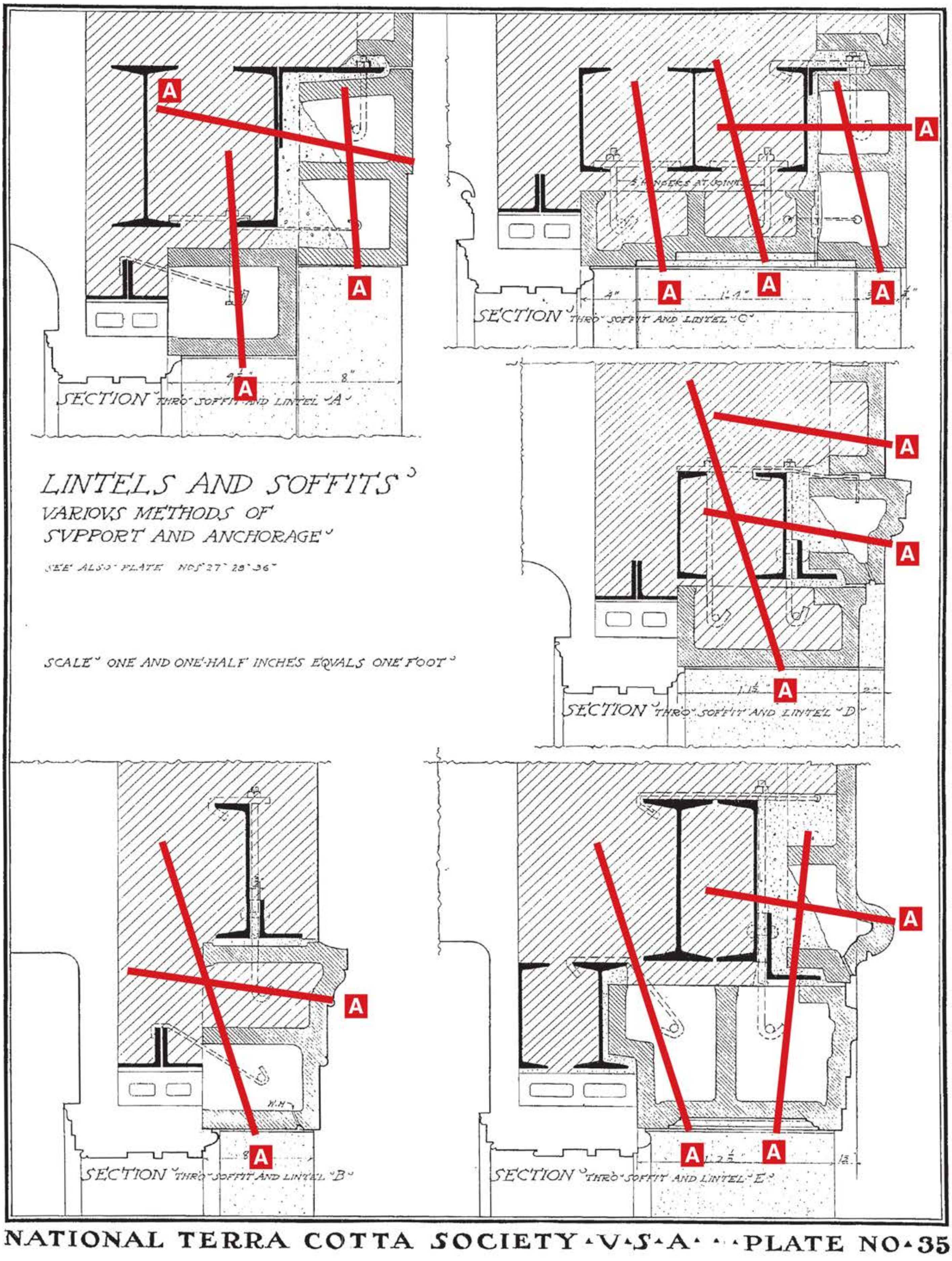
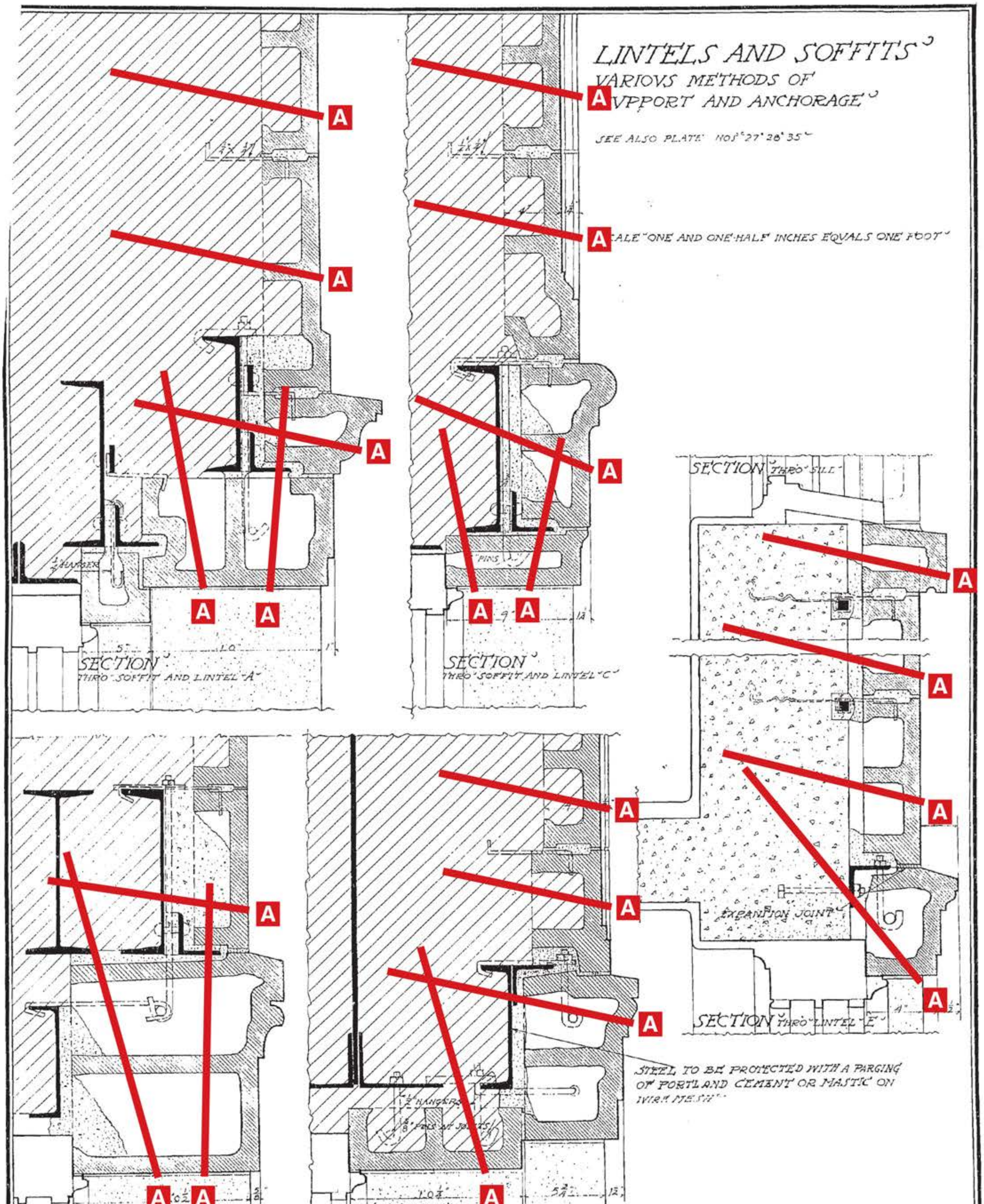
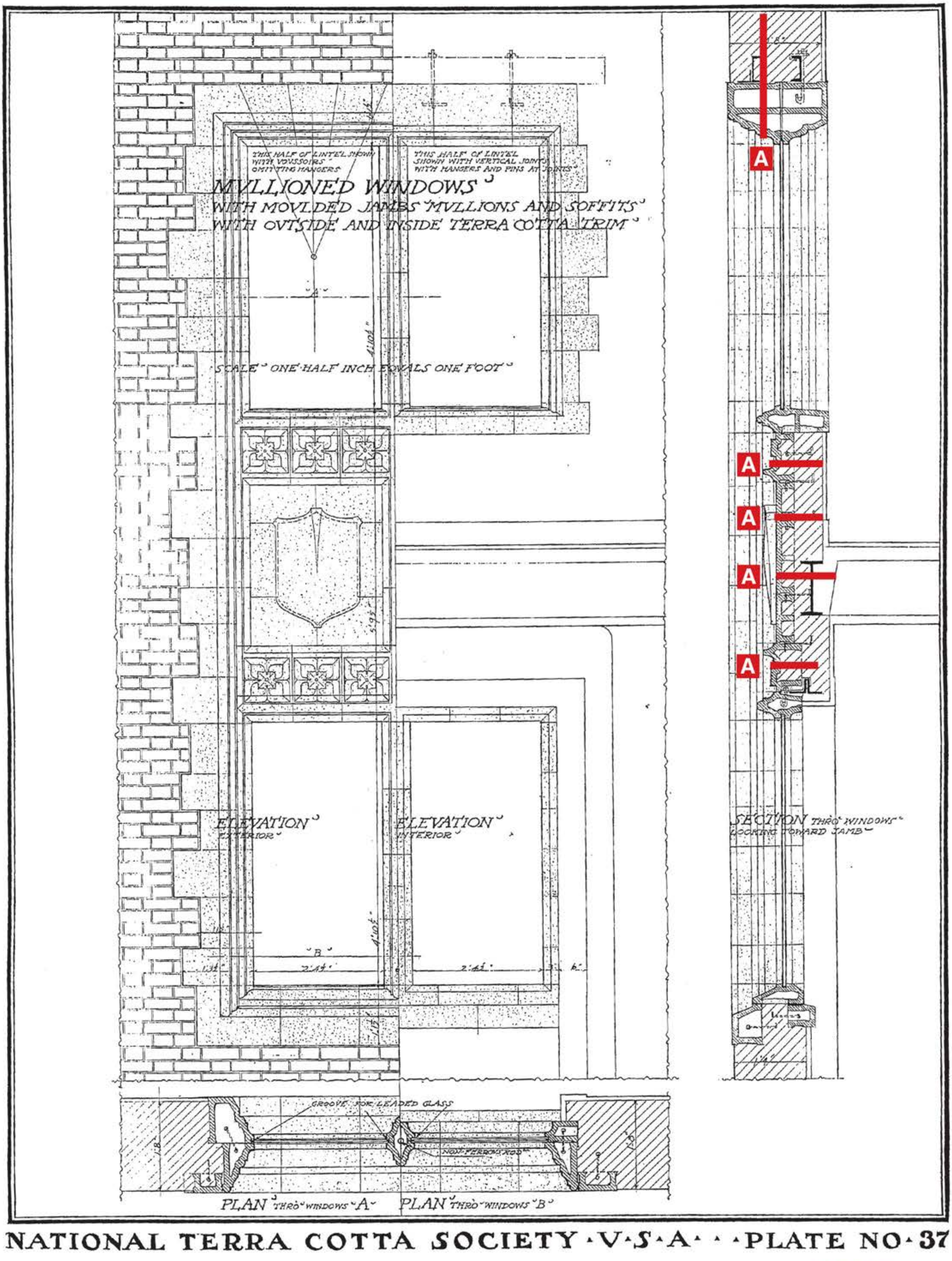


NATIONAL TERRA COTTA SOCIETY · U · S · A · · PLATE NO · 35


LINTELS AND SOFFITS
VARIOVS METHODS OF SVPPORT AND ANCHORAGE
SEE ALSO PLATE NOS 27 28 35
SCALE ONE AND ONE-HALF INCHES EQVALS ONE FOOT
SECTION THRO SOFFIT AND LINTEL "A"
SECTION THRO SOFFIT AND LINTEL "C"
SECTION THRO SILL
SECTION THRO LINTEL "E"
EXPANSION JOINT
SECTION THRO SOFFIT AND LINTEL "B"
SECTION THRO SOFFIT AND LINTEL "D"
STEEL TO BE PROTECTED WITH A PARGING OF PORTLAND CEMENT OR MASTIC ON WIRE MESH
A



This manual provides general information for use in preliminary selection of a Cintec anchor. **PAGE57**
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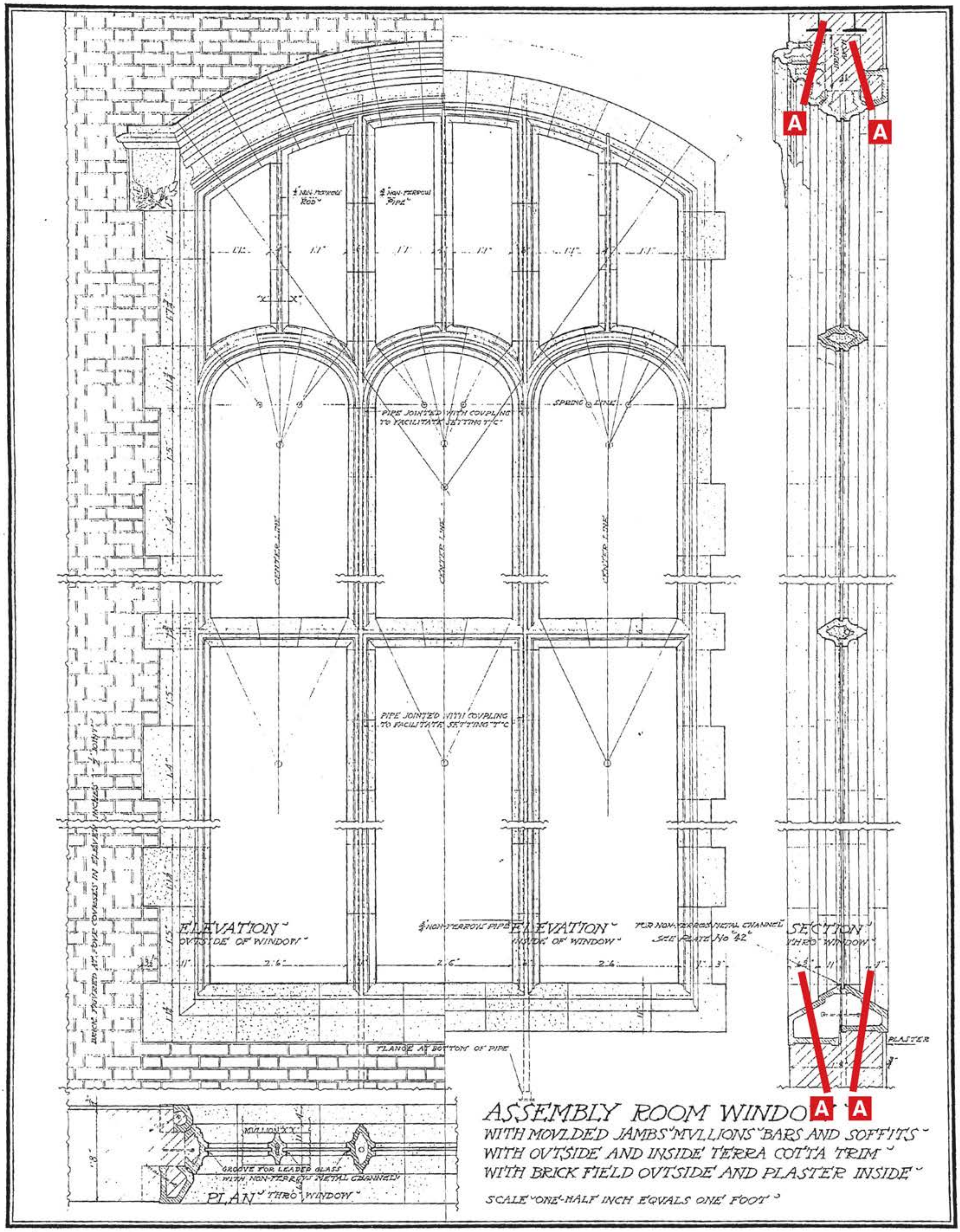
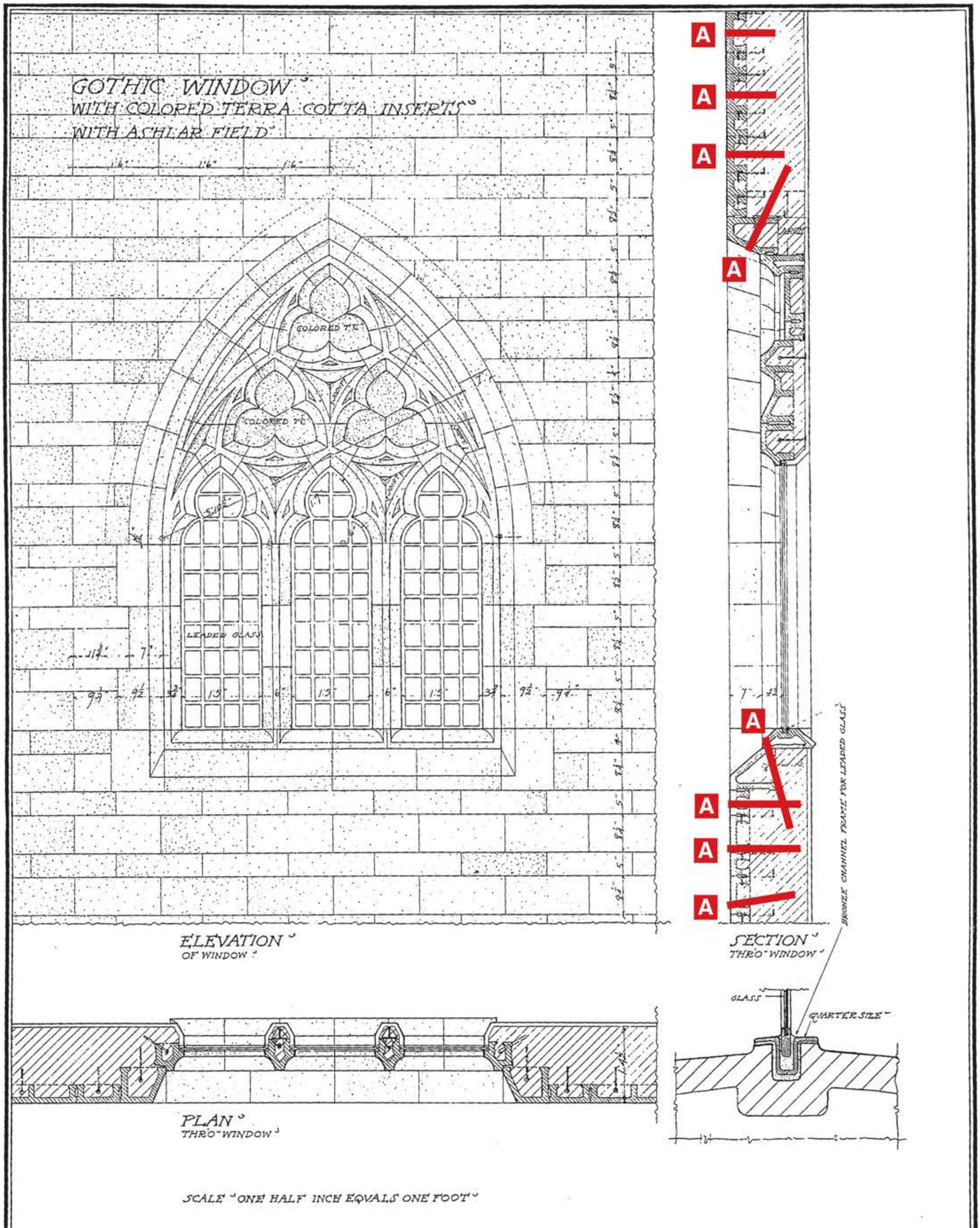
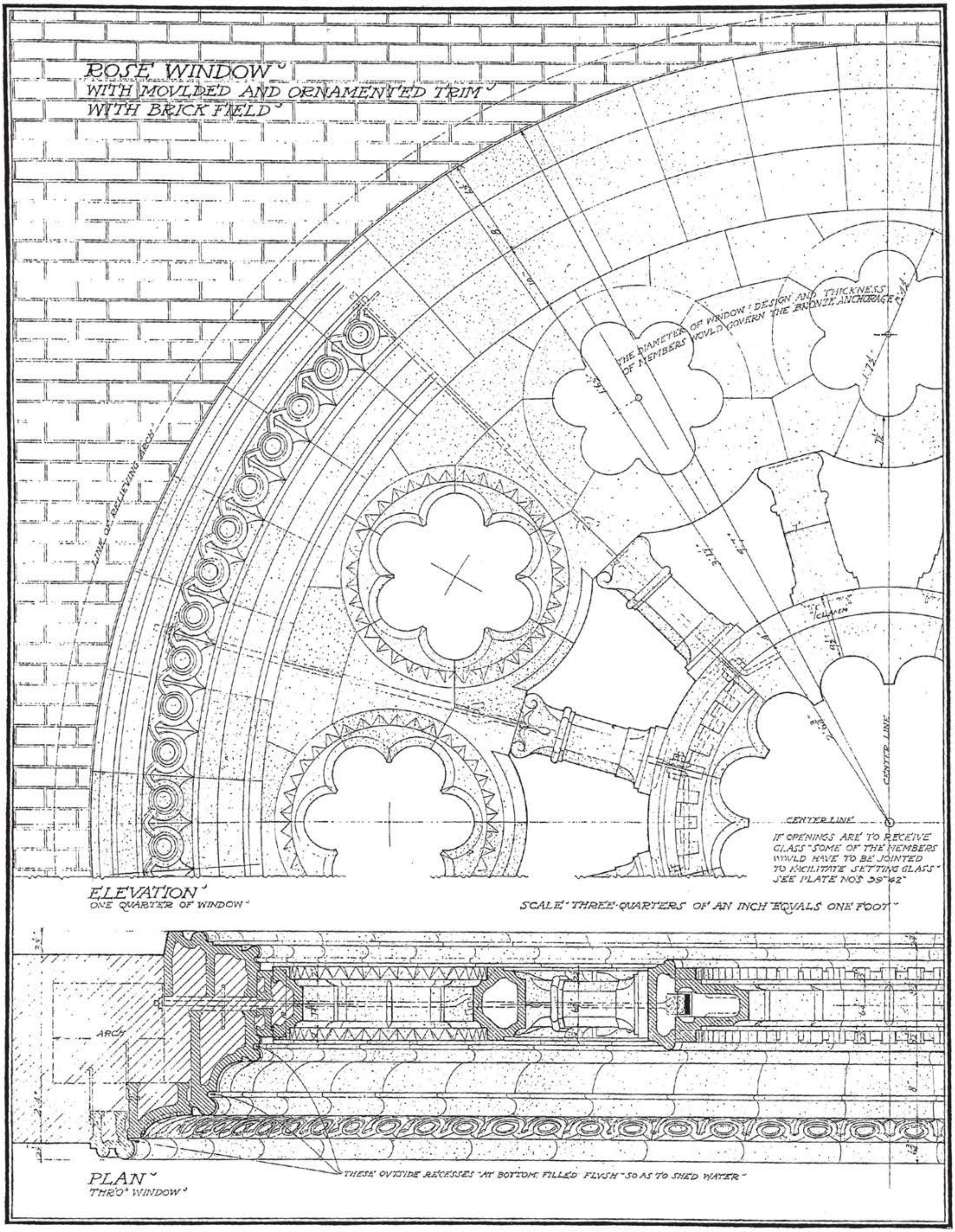
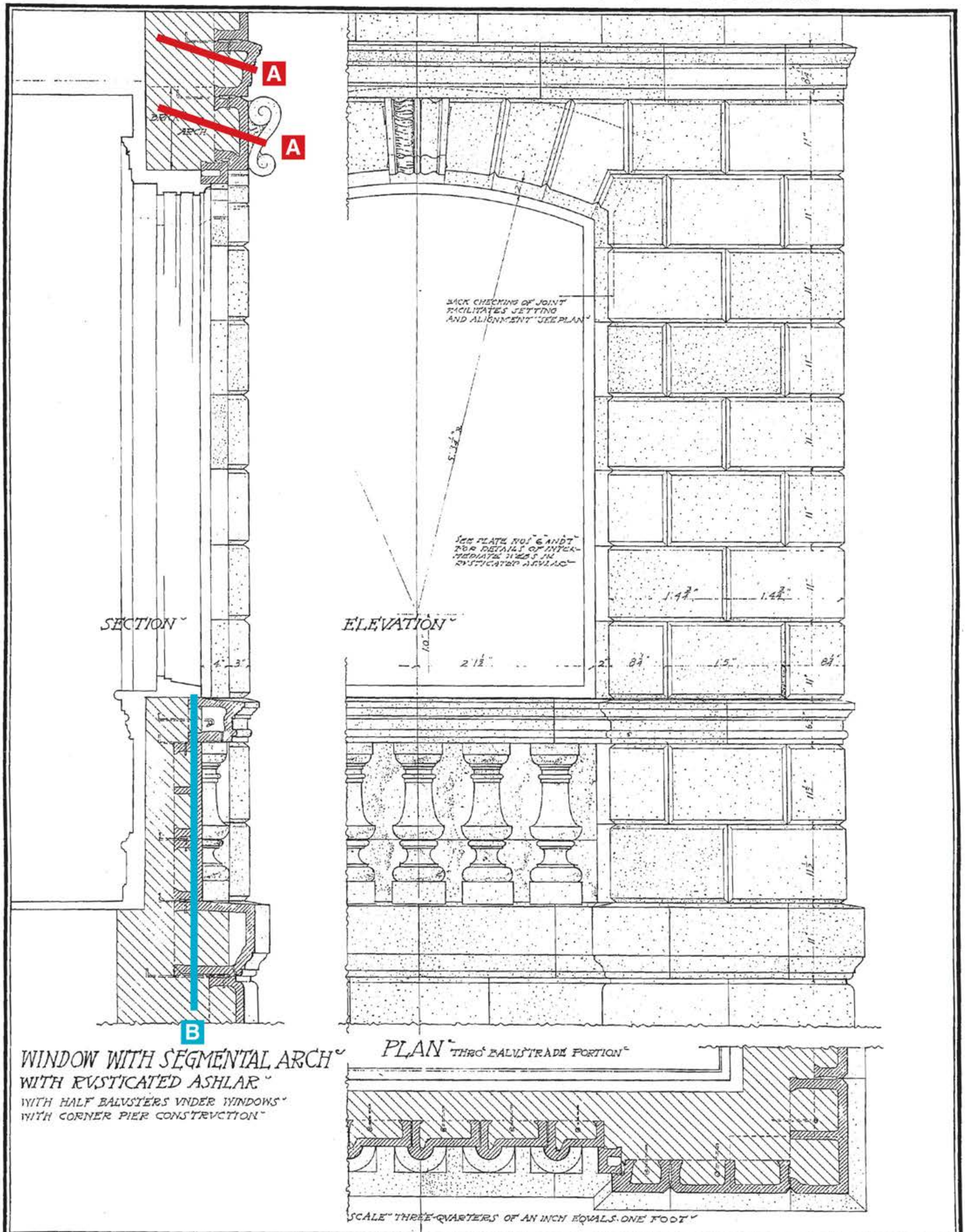


NATIONAL TERRA COTTA SOCIETY · U · S · A · · · PLATE NO · 38



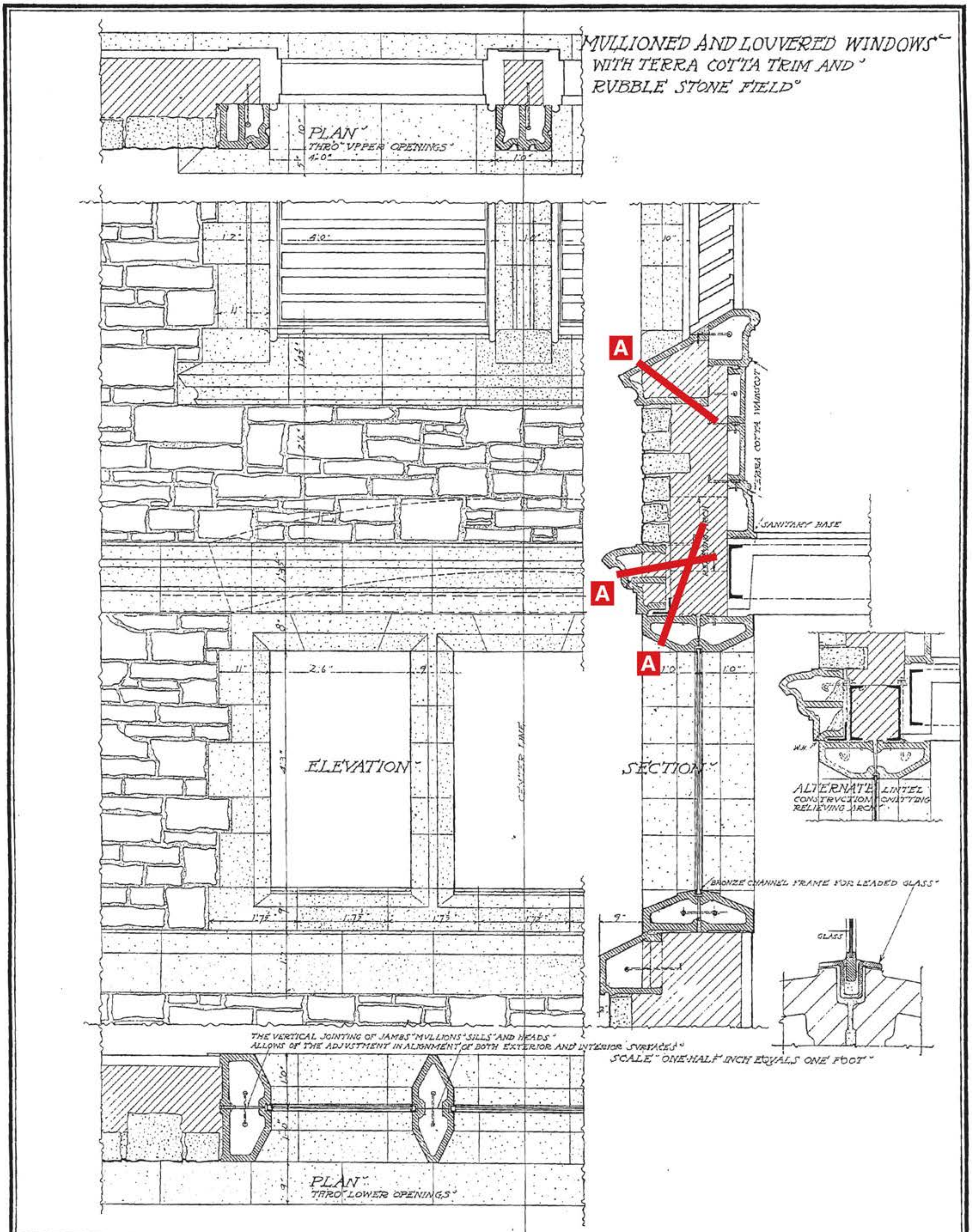
SCALE ONE HALF INCH EQUALS ONE FOOT


ROSE WINDOW
WITH MOULDED AND ORNAMENTED TRIM
WITH BRICK FIELD
LINE OF RELIEVING ARCH
THE DIAMETER OF WINDOW: DESIGN AND THICKNESS OF MEMBERS WOULD GOVERN THE BRONZE ANCHORAGE
CENTER LINE
IF OPENINGS ARE TO RECEIVE GLASS SOME OF THE MEMBERS WOULD HAVE TO BE JOINTED TO FACILITATE SETTING GLASS SEE PLATE NOS 39-42
ELEVATION
ONE QUARTER OF WINDOW
SCALE THREE QUARTERS OF AN INCH EQUALS ONE FOOT
ARCH
PLAN
THRO' WINDOW
THESE OUTSIDE RECESSES AT BOTTOM FILLED FLUSH SO AS TO SHED WATER

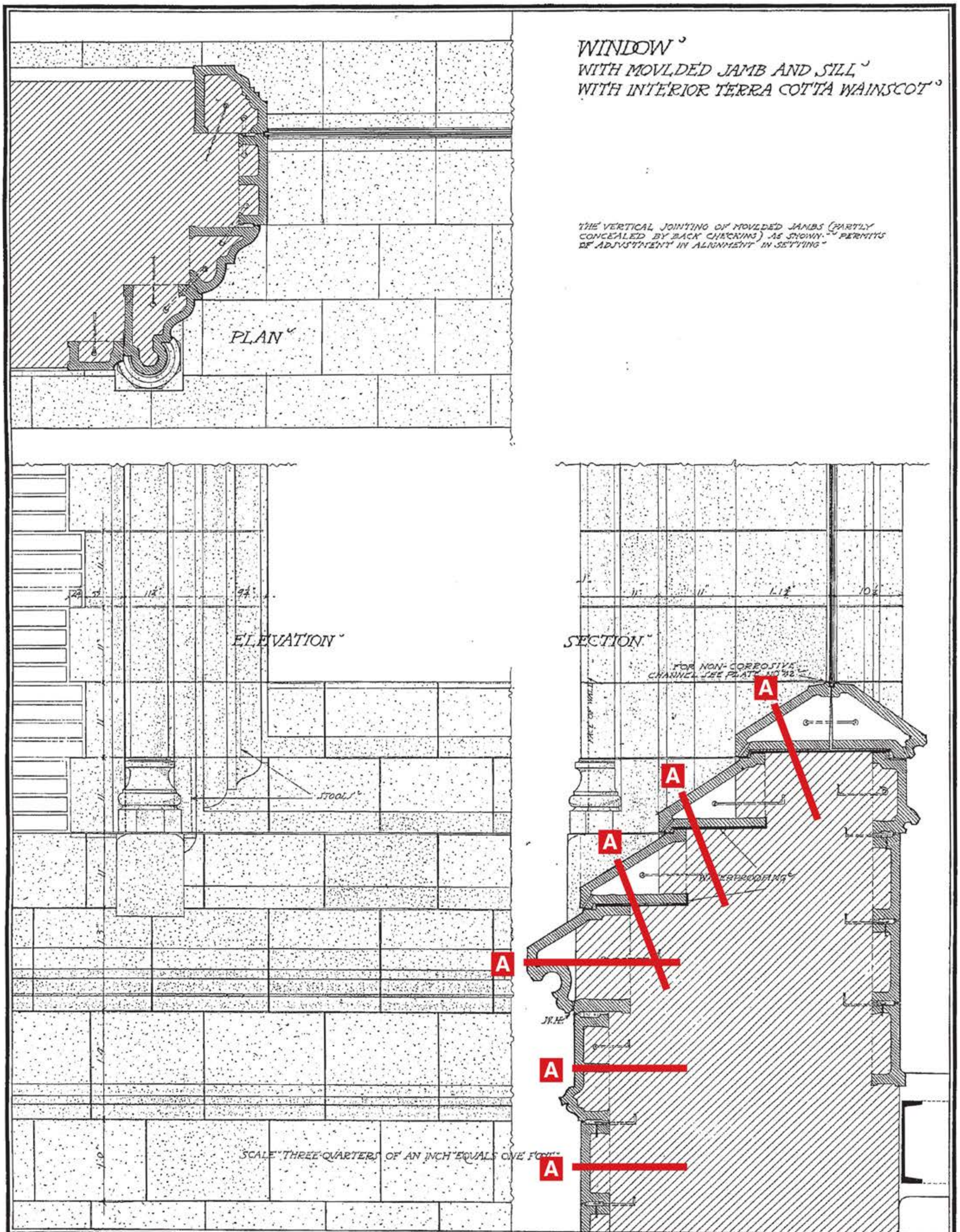


NATIONAL TERRA COTTA SOCIETY · U · S · A · · · PLATE NO · 41

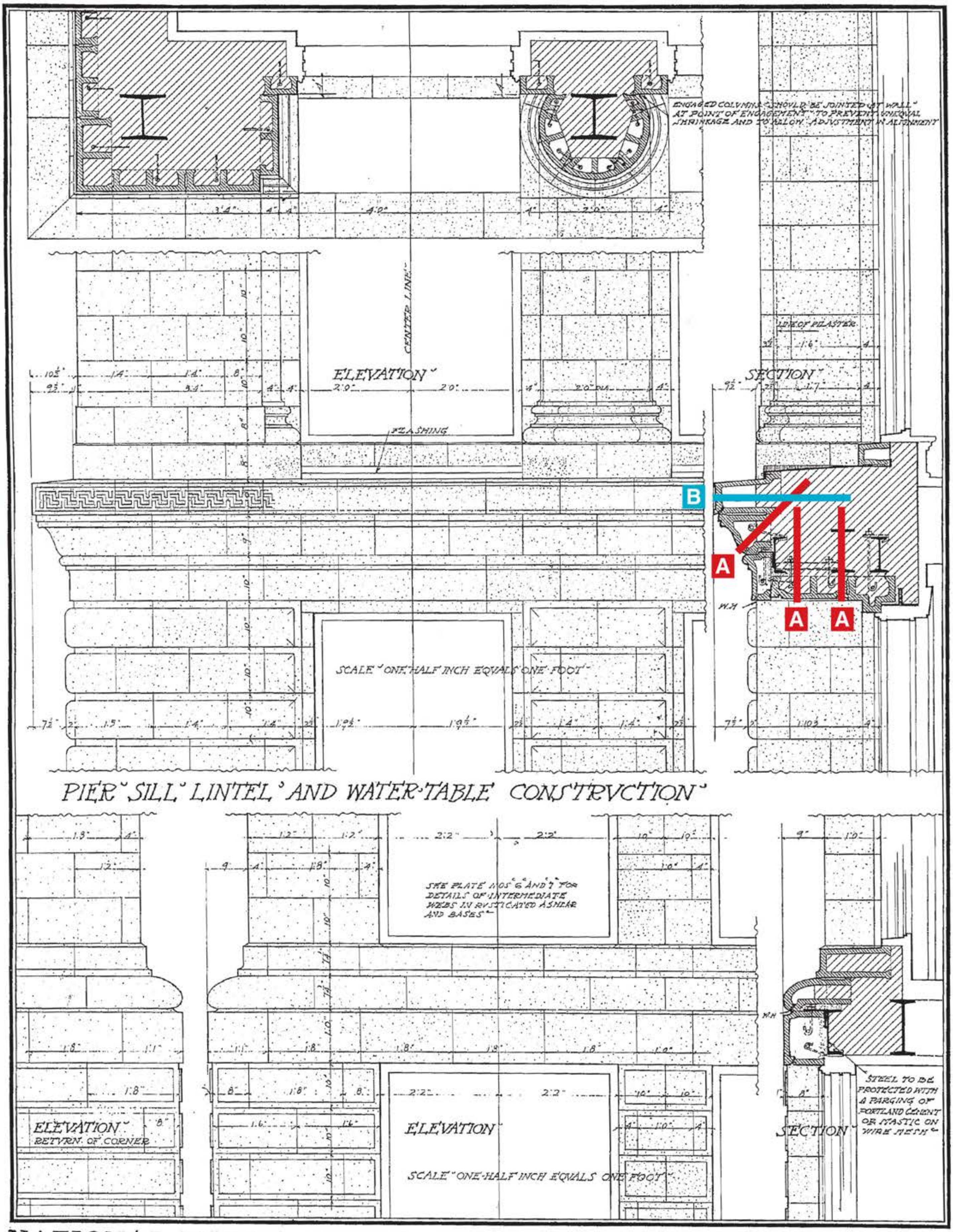
TERRA COTTA STANDARD CONSTRUCTION



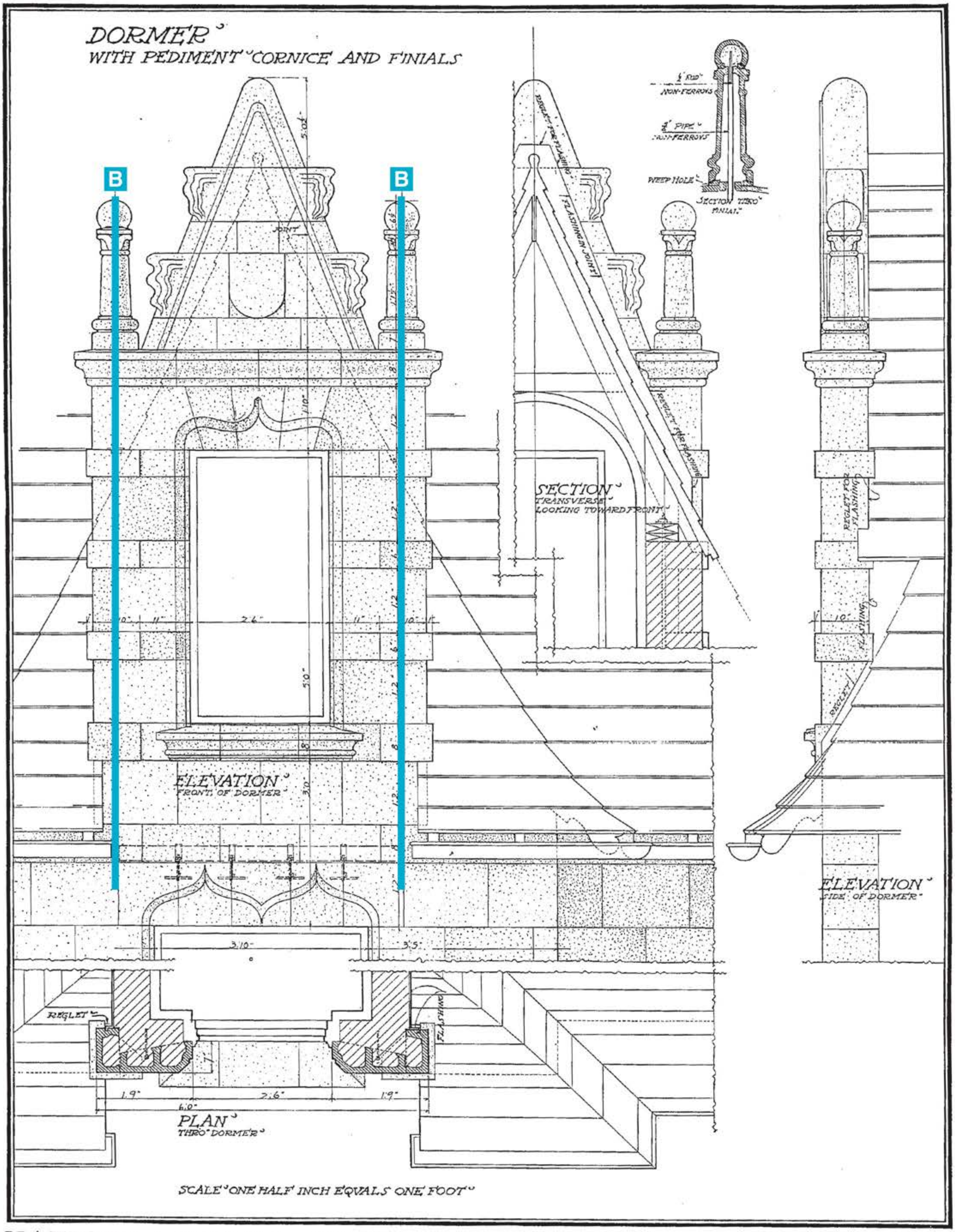
NATIONAL TERRA COTTA SOCIETY U.S.A. PLATE NO. 42



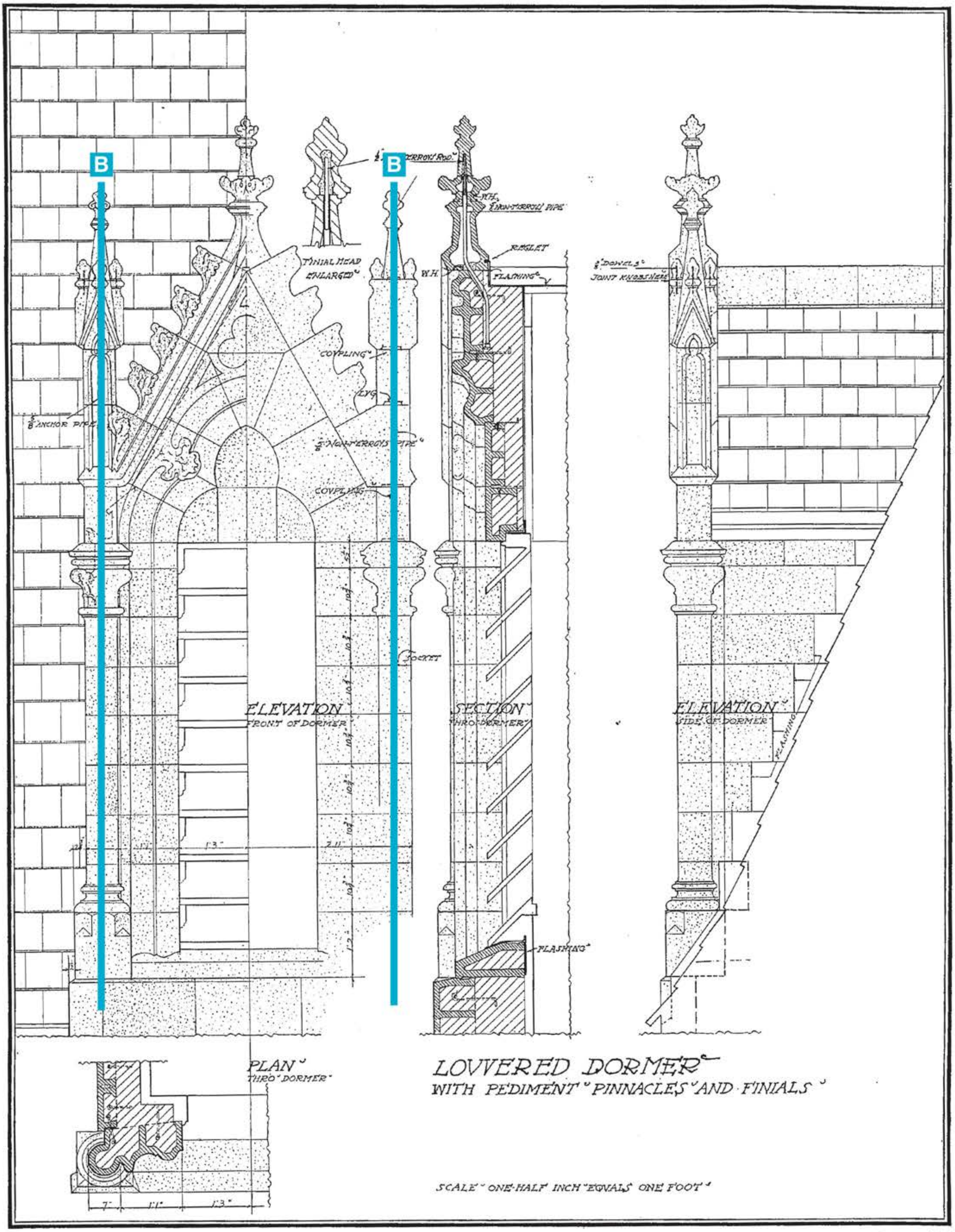
NATIONAL TERRA COTTA SOCIETY · V · S · A · · · PLATE NO · 43



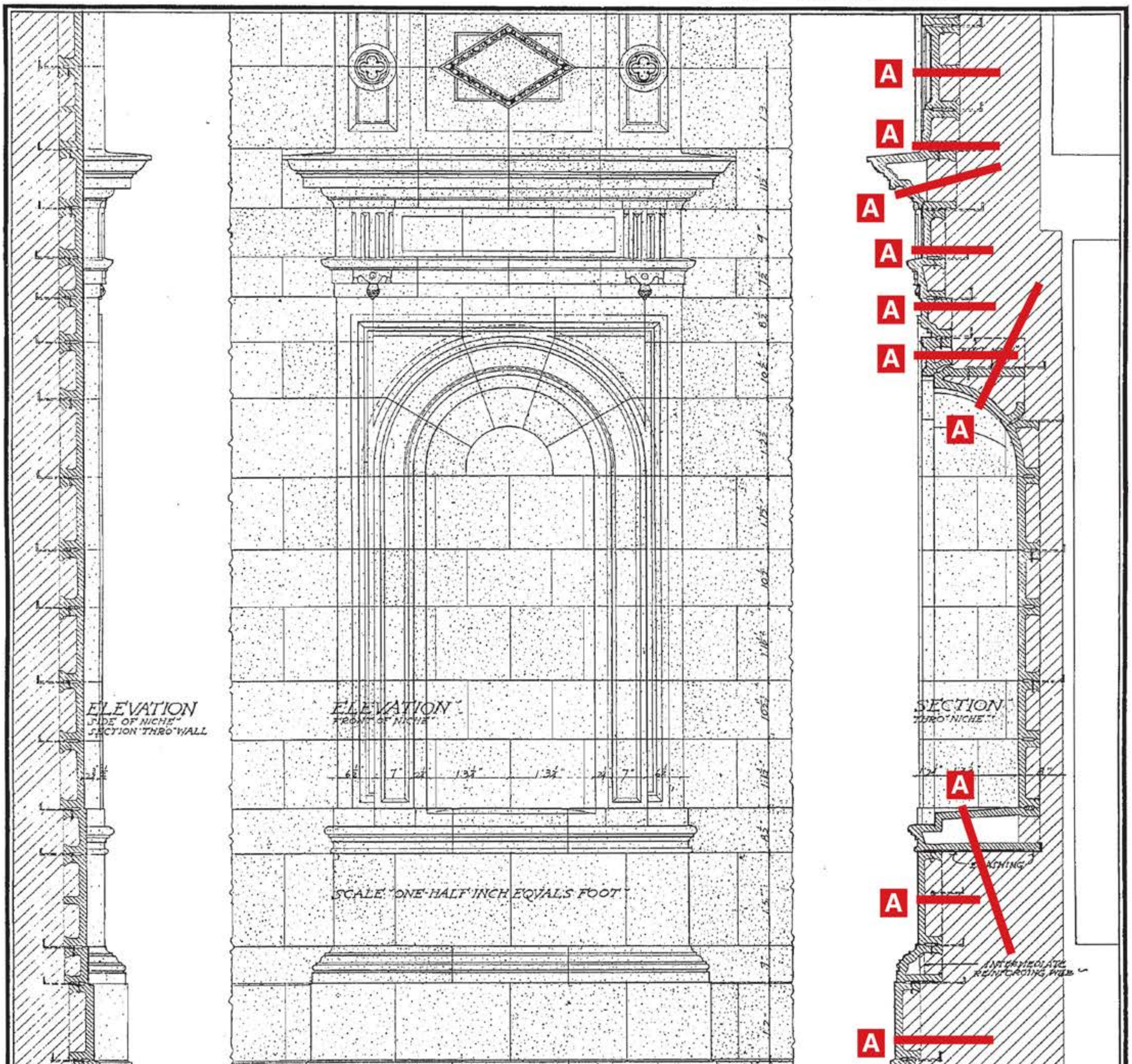
NATIONAL TERRA COTTA SOCIETY · U · S · A · · · PLATE NO · 44



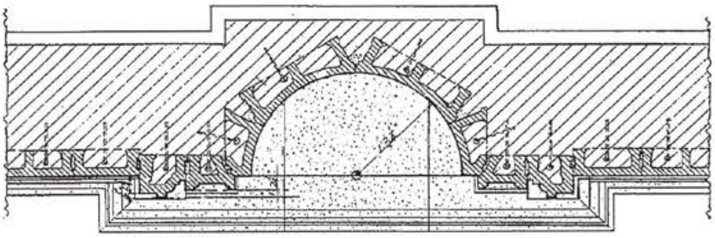
This manual provides general information for use in preliminary selection of a Cintec anchor. **PAGE65**
Final designs must be prepared by Cintec and approved by the project Architect or Engineer of Record.



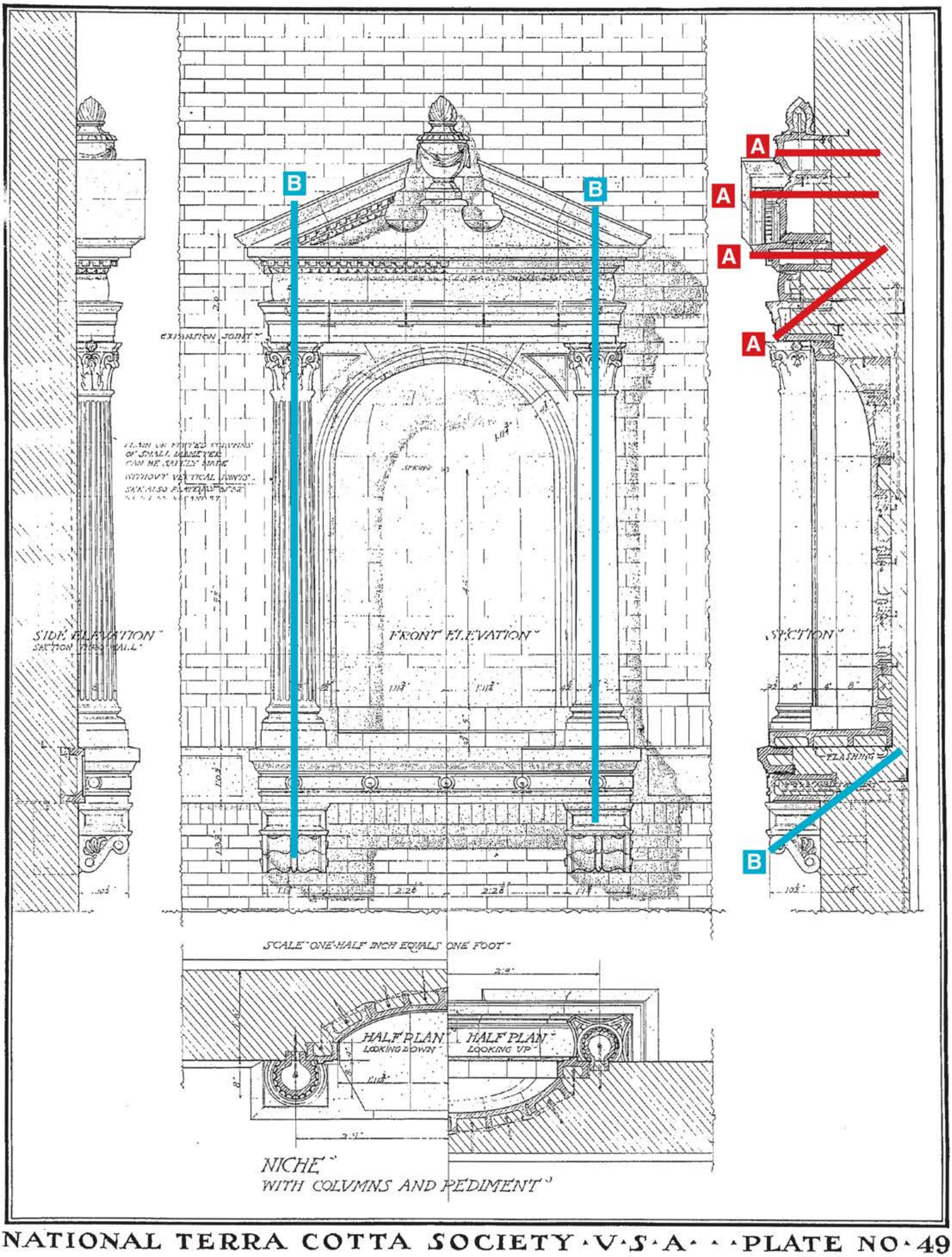
NATIONAL TERRA COTTA SOCIETY · V · S · A · · PLATE NO · 47



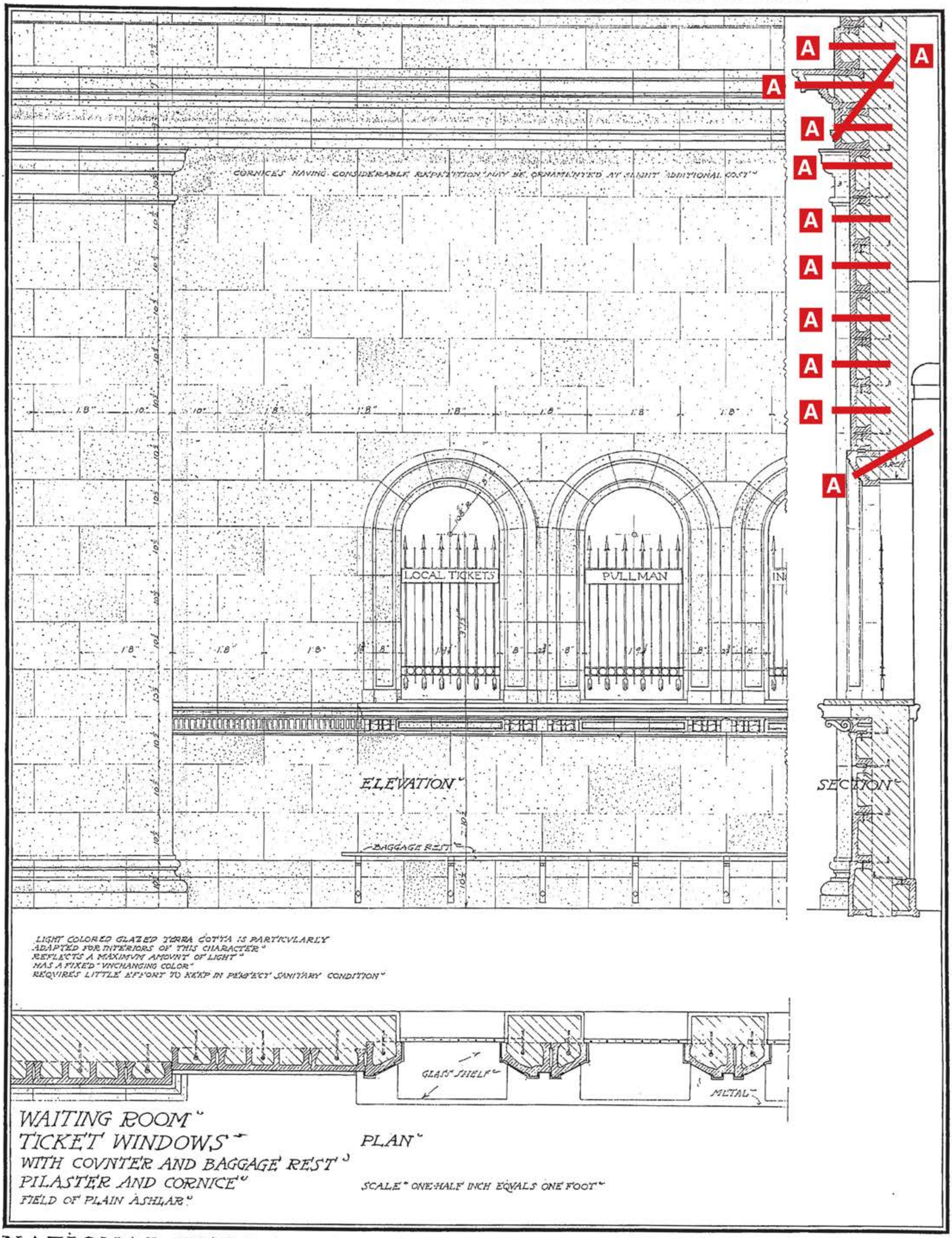
NICHE
WITH MOULDED TRIM AND CORNICE



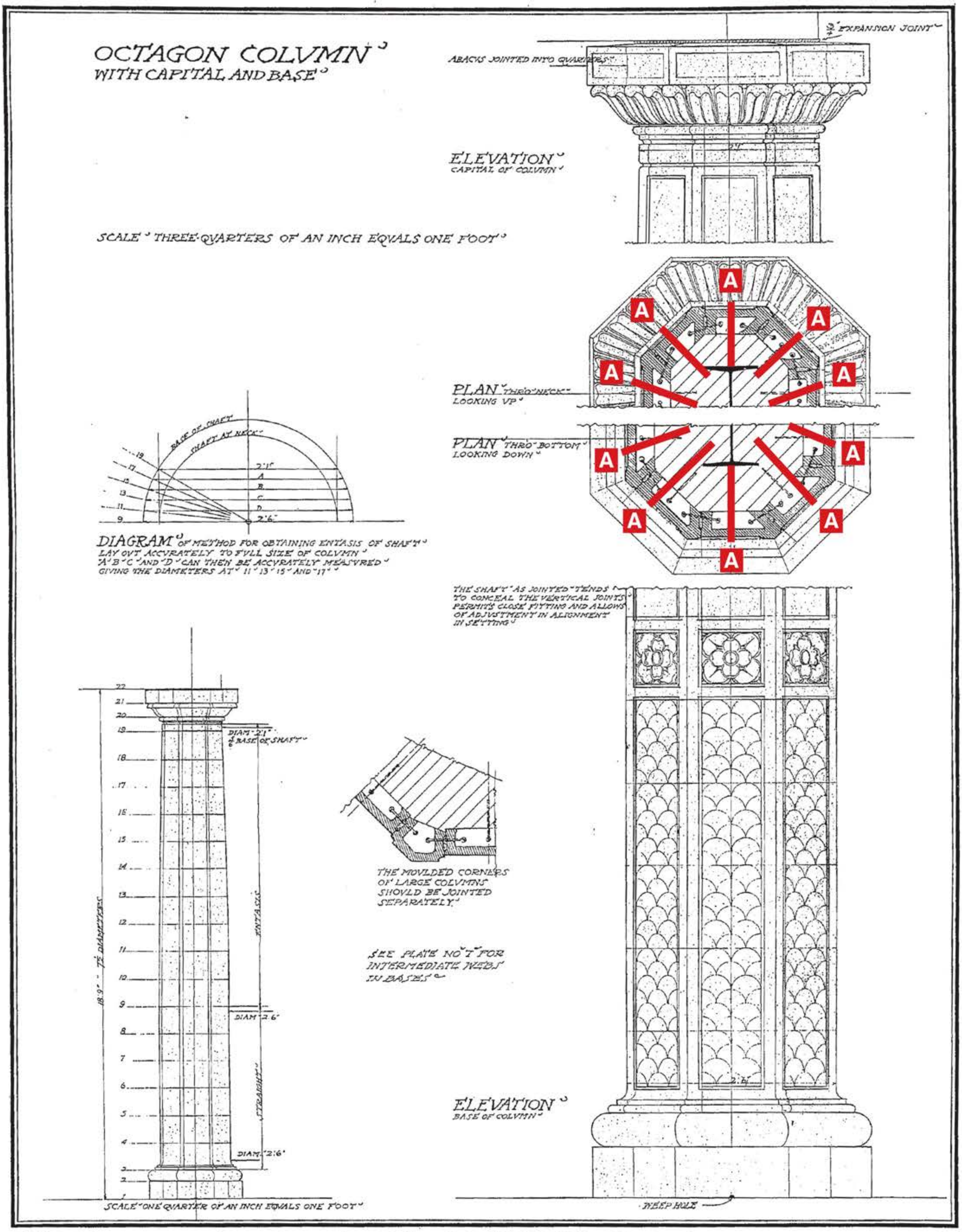
PLAN
THRO' NICHE

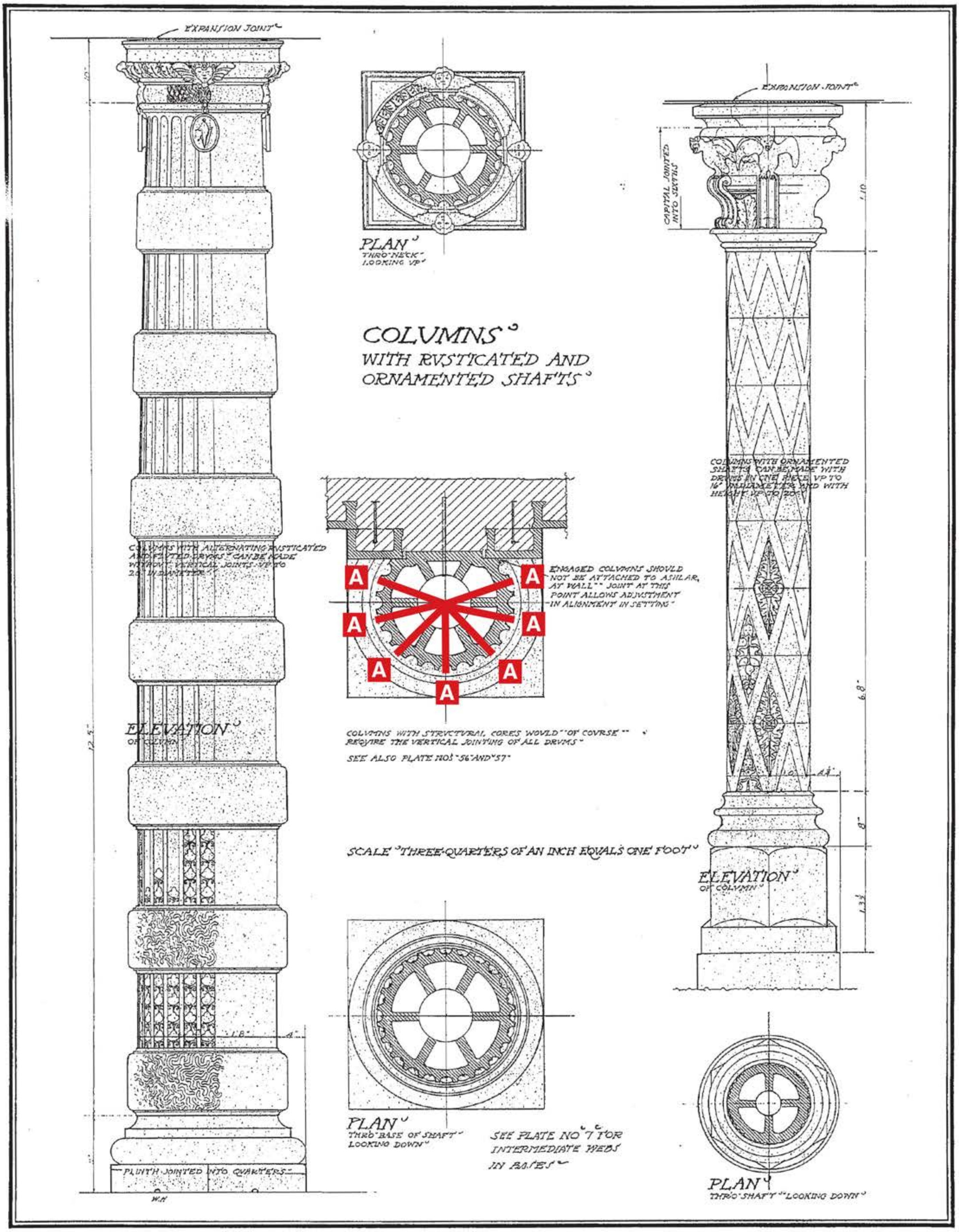


This manual provides general information for use in preliminary selection of a Cintec anchor. **PAGE68**
Final designs must be prepared by Cintec and approved by the project Architect or Engineer of Record.



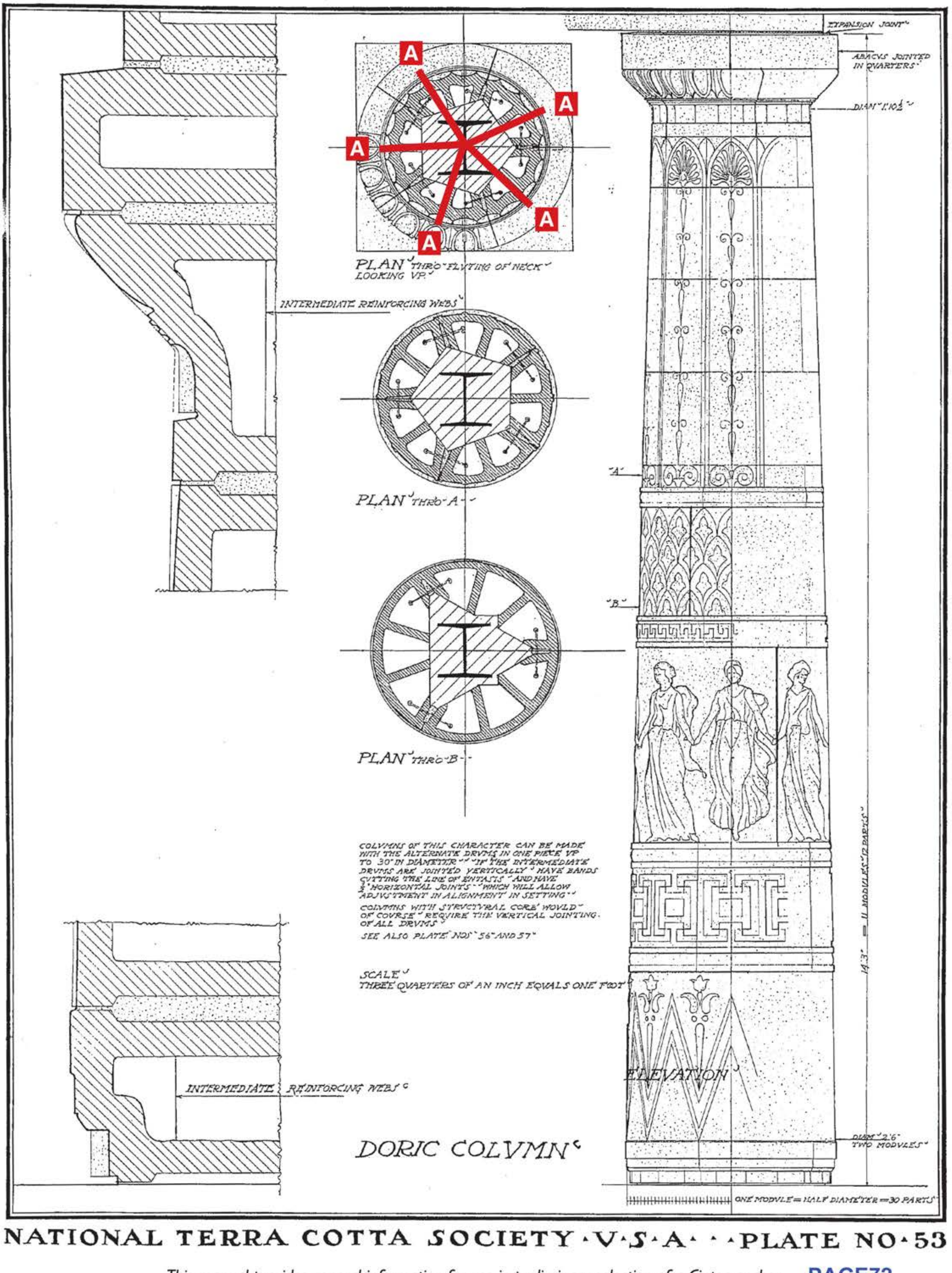
NATIONAL TERRA COTTA SOCIETY · U · S · A · · · PLATE NO · 50


OCTAGON COLUMN
WITH CAPITAL AND BASE
SCALE THREE-QUARTERS OF AN INCH EQUALS ONE FOOT
½" EXPANSION JOINT
ABACUS JOINTED INTO QUARTERS
ELEVATION
CAPITAL OF COLUMN
A
PLAN THRO' NECK
LOOKING UP
PLAN THRO' BOTTOM
LOOKING DOWN
BASE OF SHAFT
SHAFT AT NECK
2'1"
A
B
C
D
2'6"
DIAGRAM OF METHOD FOR OBTAINING ENTASIS OF SHAFT
LAY OUT ACCURATELY TO FULL SIZE OF COLUMN
"A" "B" "C" AND "D" CAN THEN BE ACCURATELY MEASURED
GIVING THE DIAMETERS AT 11 13 15 AND 17
THE SHAFT AS JOINTED TENDS
TO CONCEAL THE VERTICAL JOINTS
PERMITS CLOSE FITTING AND ALLOWS
OF ADJUSTMENT IN ALIGNMENT
IN SETTING
DIAM 2'1"
⅚ BASE OF SHAFT
ENTASIS
STRAIGHT
DIAM 2'6"
DIAM 2'6"
THE MOULDED CORNERS
OF LARGE COLUMNS
SHOULD BE JOINTED
SEPARATELY
SEE PLATE NO 7 FOR
INTERMEDIATE WEBS
IN BASES
ELEVATION
BASE OF COLUMN
SCALE ONE QUARTER OF AN INCH EQUALS ONE FOOT
WEEP HOLE

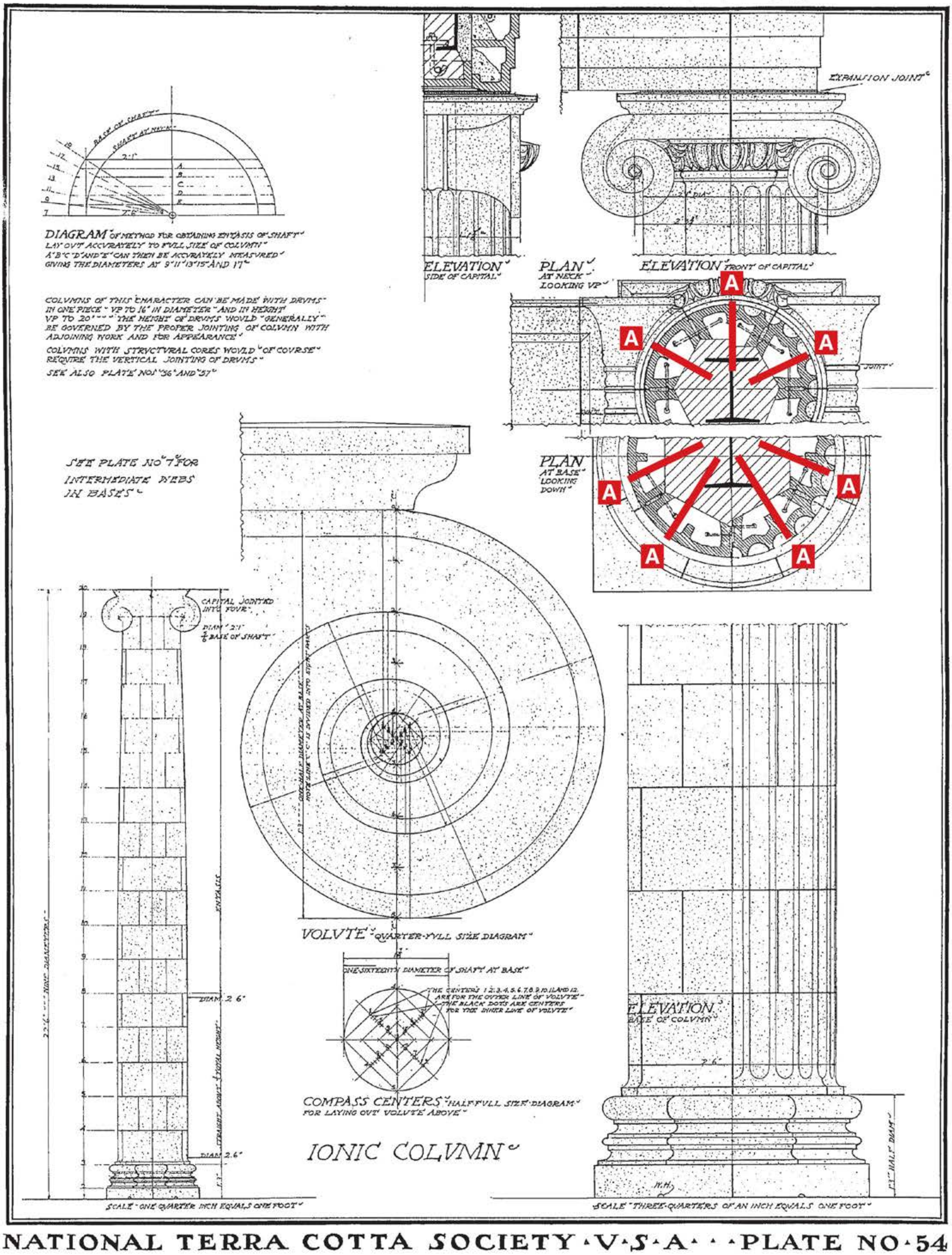


NATIONAL TERRA COTTA SOCIETY · V · S · A · · · PLATE NO · 52

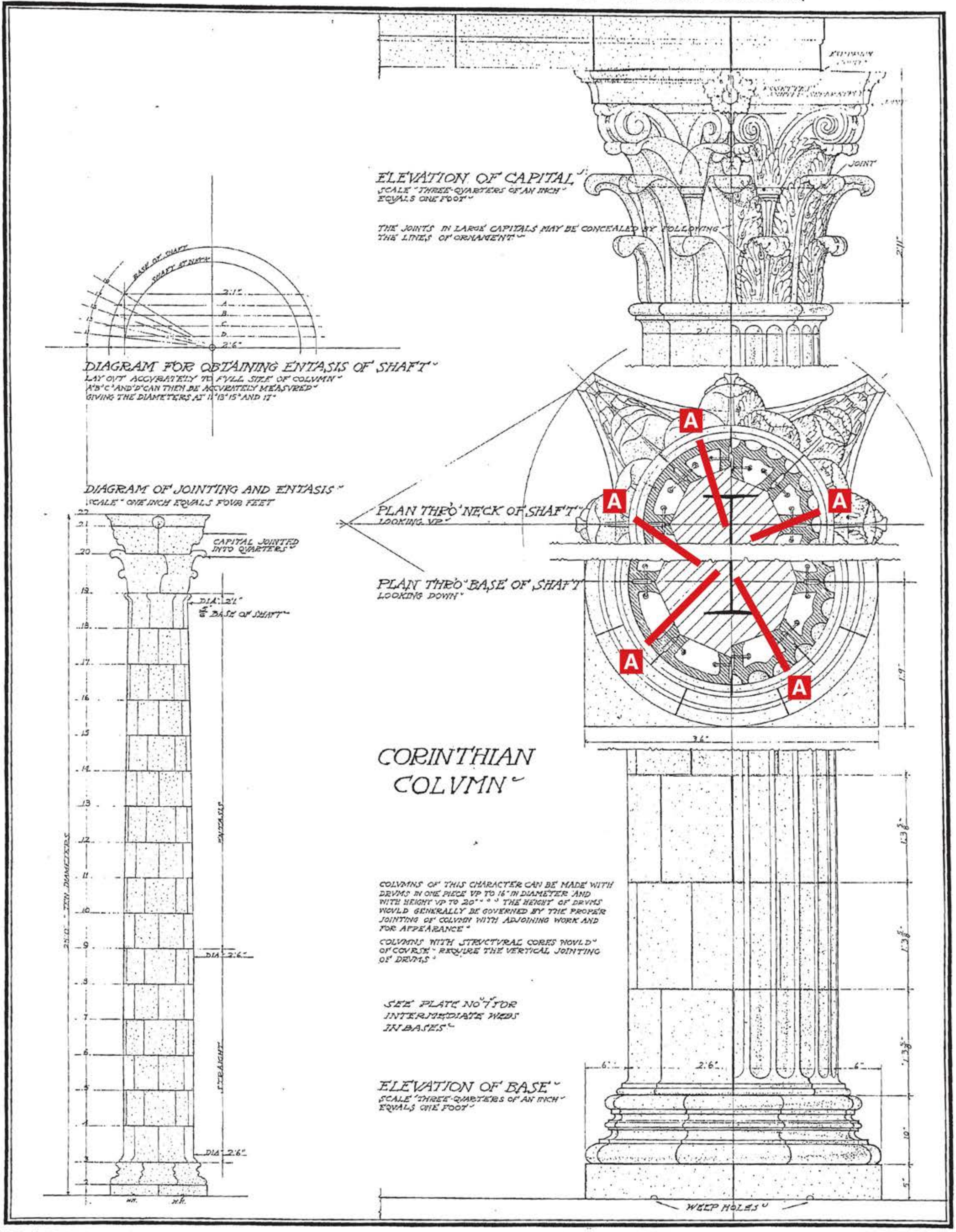
TERRA COTTA · STANDARD CONSTRUCTION



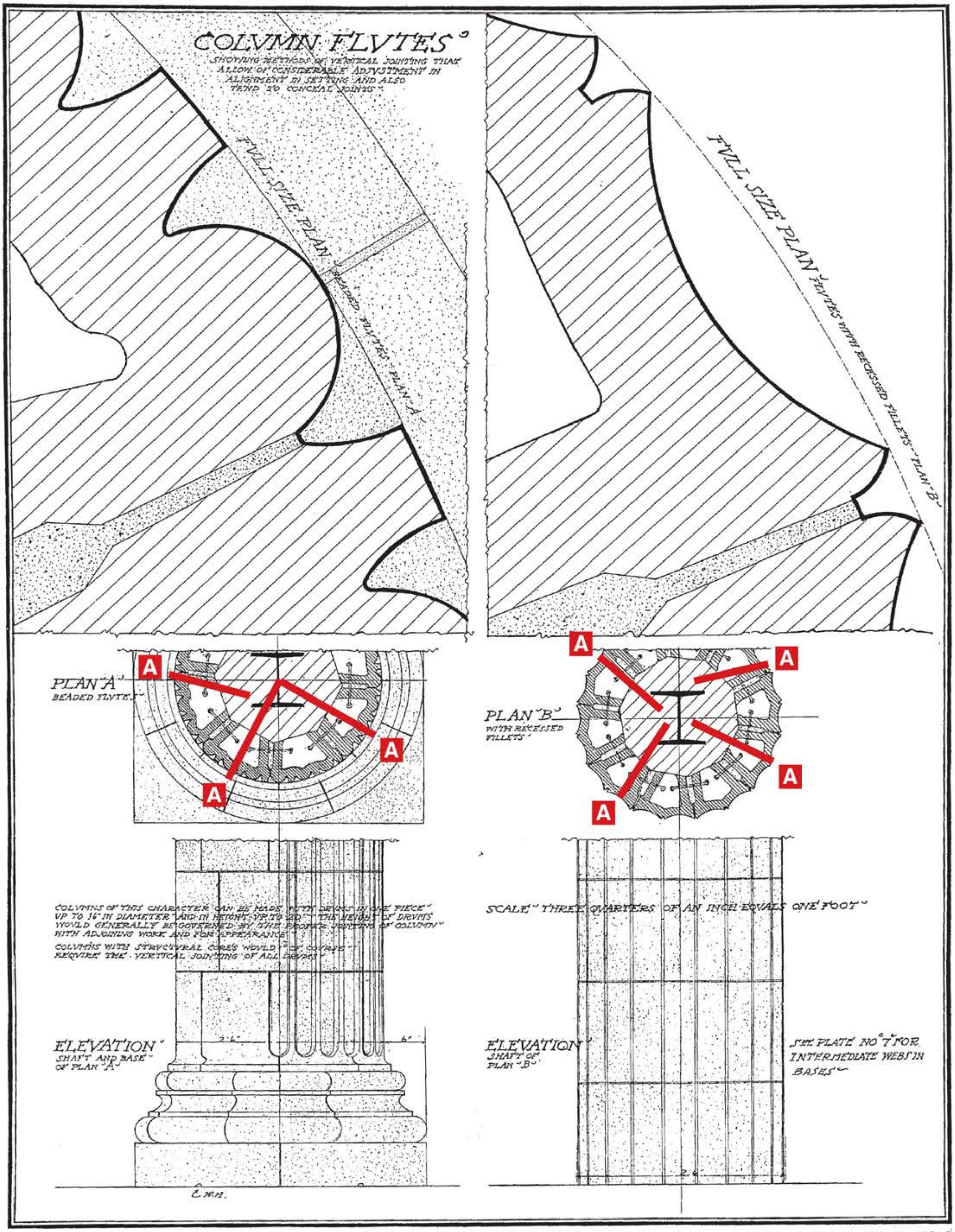
NATIONAL TERRA COTTA SOCIETY · U · S · A · · PLATE NO · 53

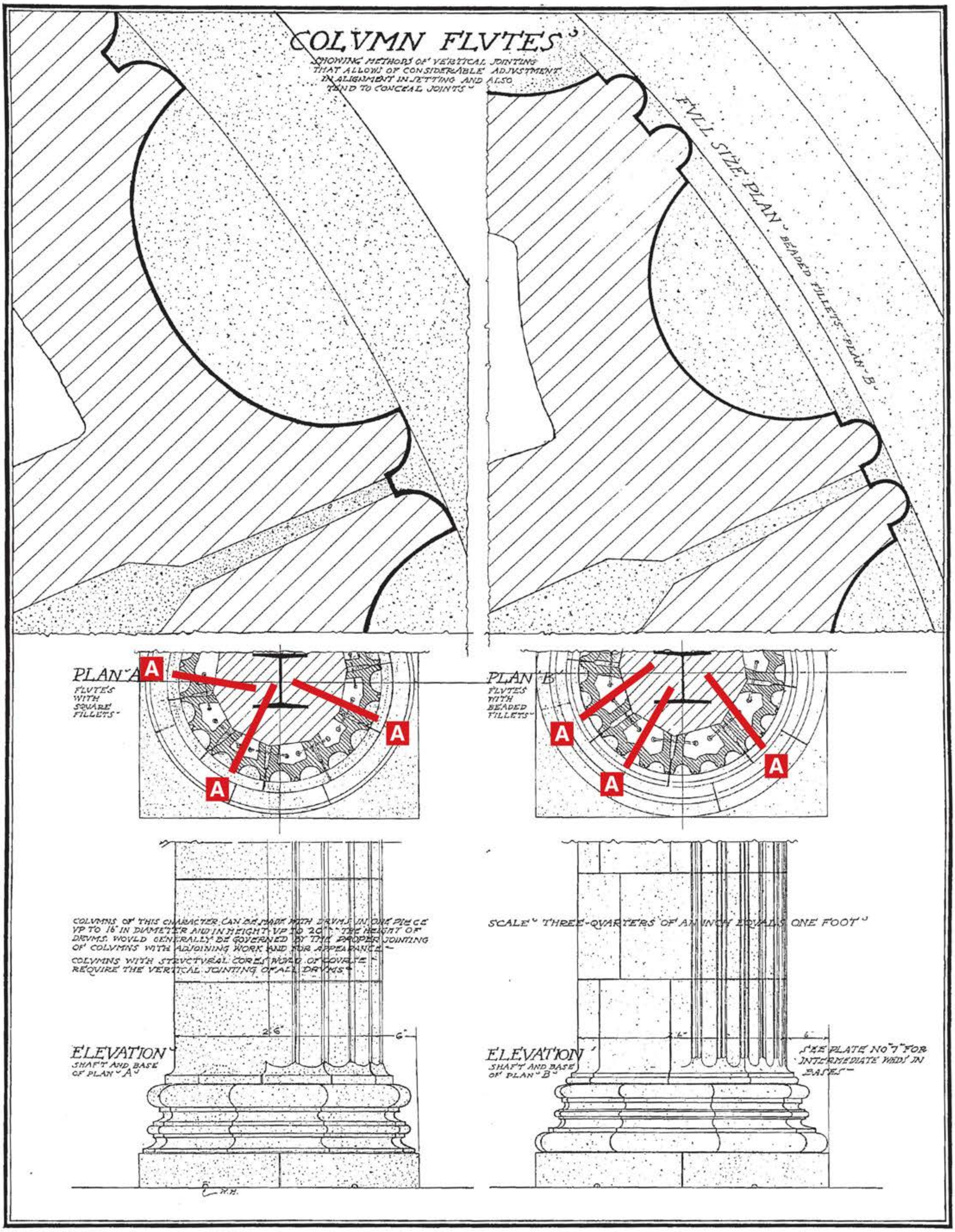


This manual provides general information for use in preliminary selection of a Cintec anchor.
Final designs must be prepared by Cintec and approved by the project Architect or Engineer of Record.

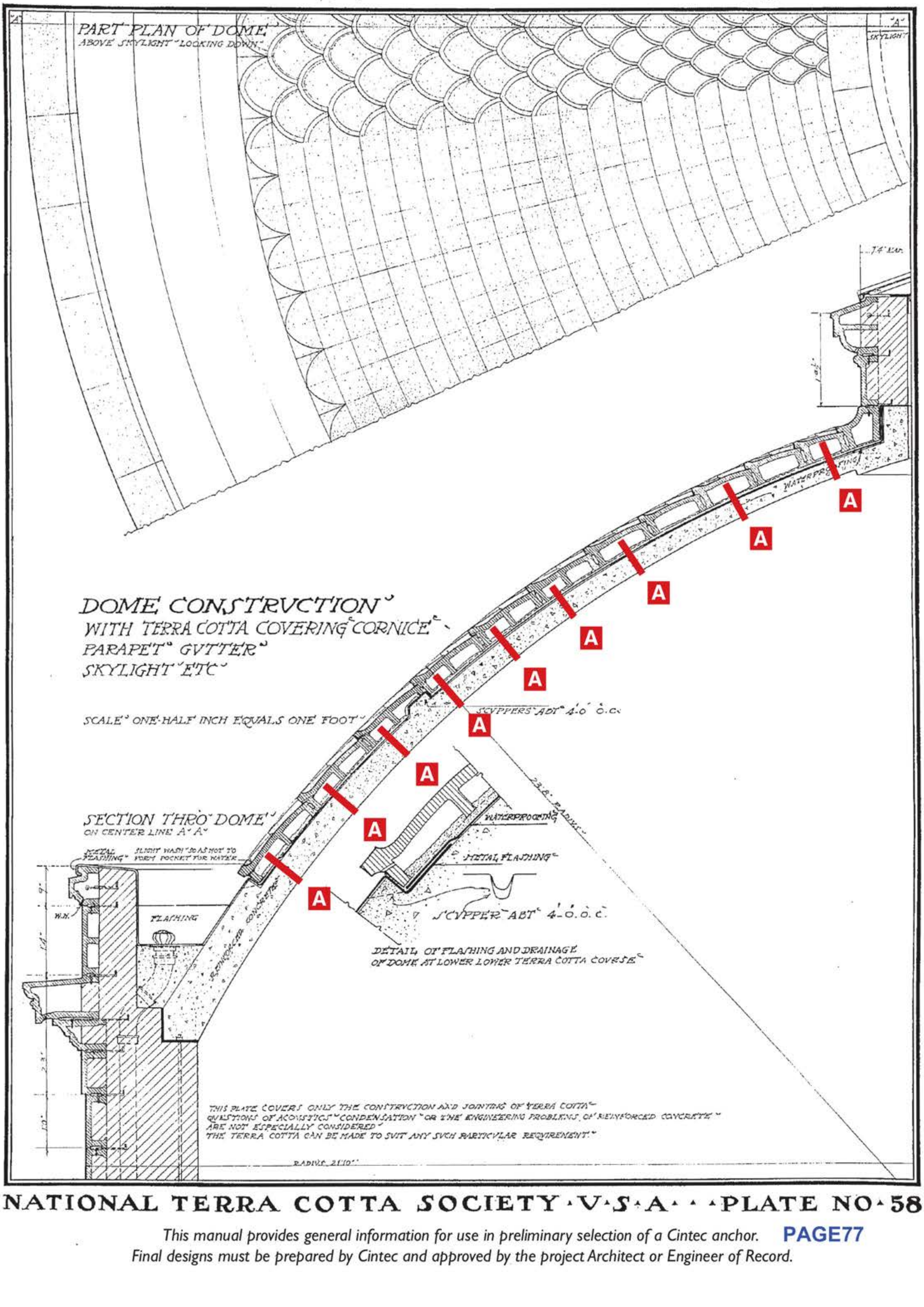


NATIONAL TERRA COTTA SOCIETY · U · S · A · · PLATE NO · 55

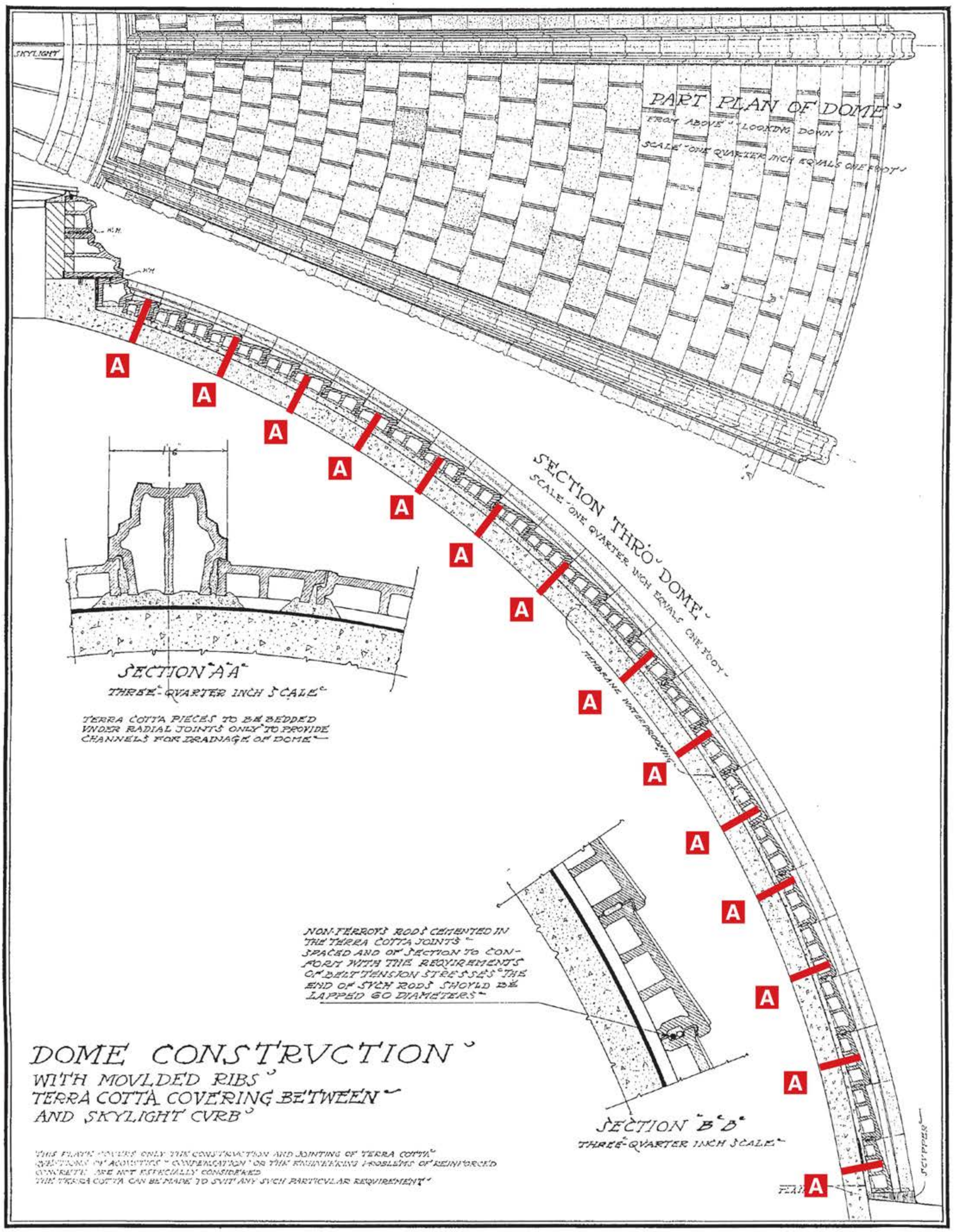

COLUMN FLUTES
SHOWING METHODS OF VERTICAL JOINTING THAT ALLOW OF CONSIDERABLE ADJUSTMENT IN ALIGNMENT IN SETTING AND ALSO TEND TO CONCEAL JOINTS
FULL SIZE PLAN BEADED FLUTES PLAN A
FULL SIZE PLAN FLUTES WITH RECESSED FILLETS PLAN B
PLAN A
BEADED FLUTES
PLAN B
WITH RECESSED FILLETS
A
COLUMNS OF THIS CHARACTER CAN BE MADE WITH DRUMS IN ONE PIECE UP TO 16" IN DIAMETER AND IN HEIGHT UP TO 20" THE HEIGHT OF DRUMS WOULD GENERALLY BE GOVERNED BY THE PROPER JOINTING OF COLUMN WITH ADJOINING WORK AND FOR APPEARANCE
COLUMNS WITH STRUCTURAL CORES WOULD OF COURSE REQUIRE THE VERTICAL JOINTING OF ALL DRUMS
SCALE THREE QUARTERS OF AN INCH EQUALS ONE FOOT
ELEVATION
SHAFT AND BASE OF PLAN A
ELEVATION
SHAFT OF PLAN B
SEE PLATE NO 7 FOR INTERMEDIATE WEBS IN BASES
C.H.H.



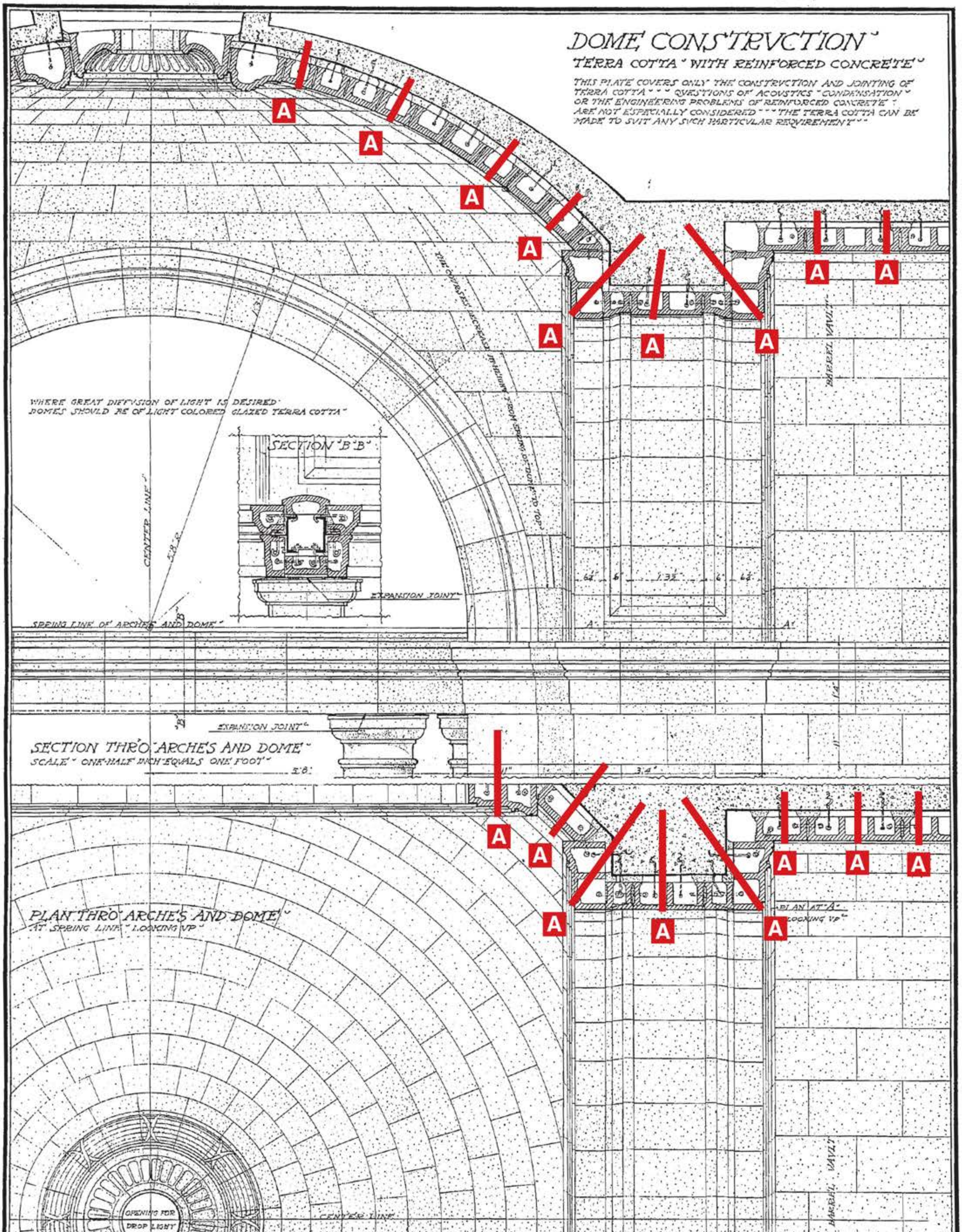
This manual provides general information for use in preliminary selection of a Cintec anchor. **PAGE76**
Final designs must be prepared by Cintec and approved by the project Architect or Engineer of Record.



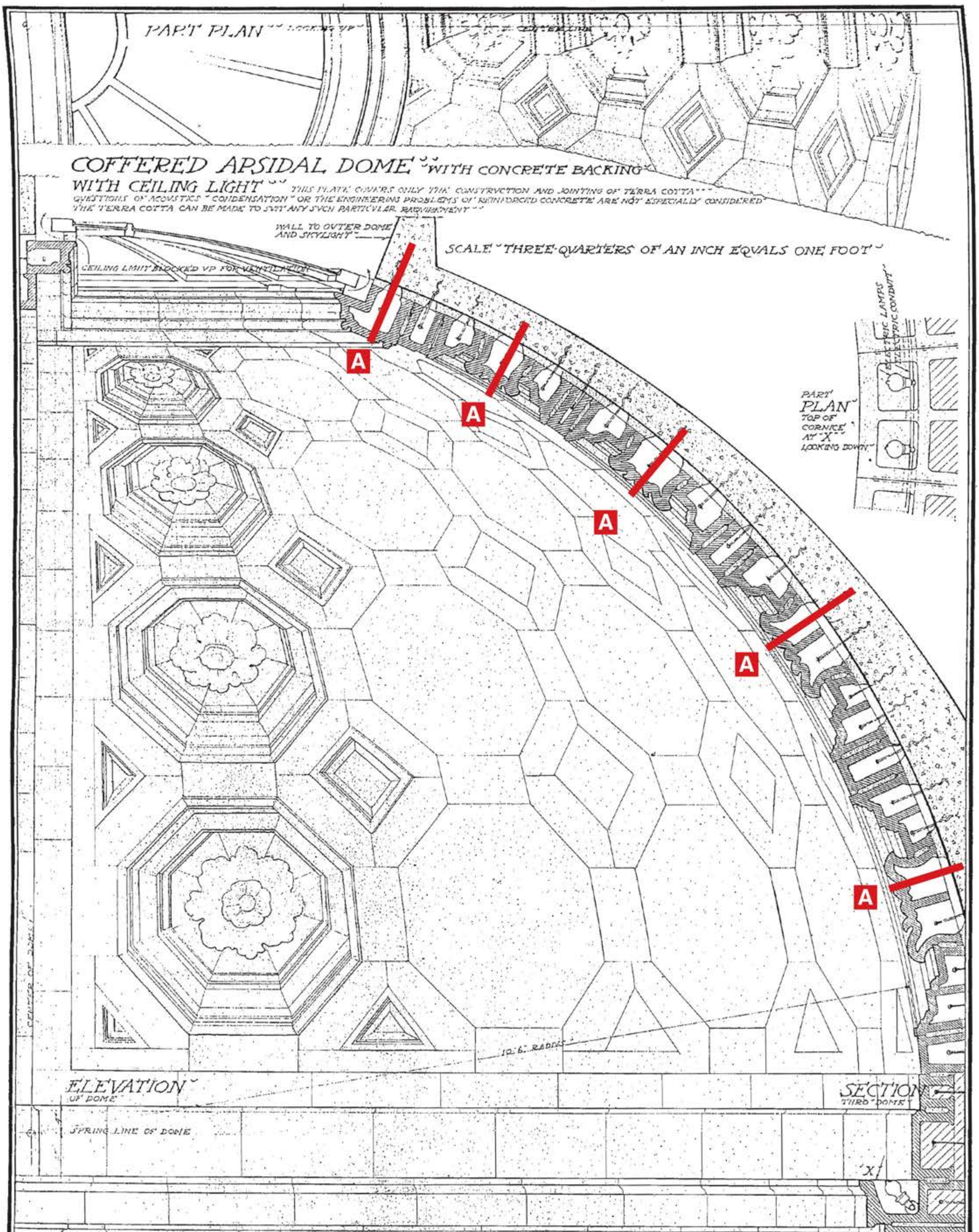
PART PLAN OF DOME ABOVE SKYLIGHT LOOKING DOWN
DOME CONSTRUCTION WITH TERRA COTTA COVERING CORNICE PARAPET GUTTER SKYLIGHT ETC
SCALE ONE-HALF INCH EQUALS ONE FOOT
SECTION THRO DOME ON CENTER LINE A-A
SCUPPERS ABT 4'-0" O.C.
WATERPROOFING
METAL FLASHING
SCUPPER ABT 4'-0" O.C.
DETAIL OF FLASHING AND DRAINAGE OF DOME AT LOWER TERRA COTTA COURSE
FLASHING
REINFORCED CONCRETE
A
THIS PLATE COVERS ONLY THE CONSTRUCTION AND JOINTING OF TERRA COTTA
QUESTIONS OF ACOUSTICS CONDENSATION OR THE ENGINEERING PROBLEMS OF REINFORCED CONCRETE ARE NOT ESPECIALLY CONSIDERED
THE TERRA COTTA CAN BE MADE TO SUIT ANY SUCH PARTICULAR REQUIREMENT



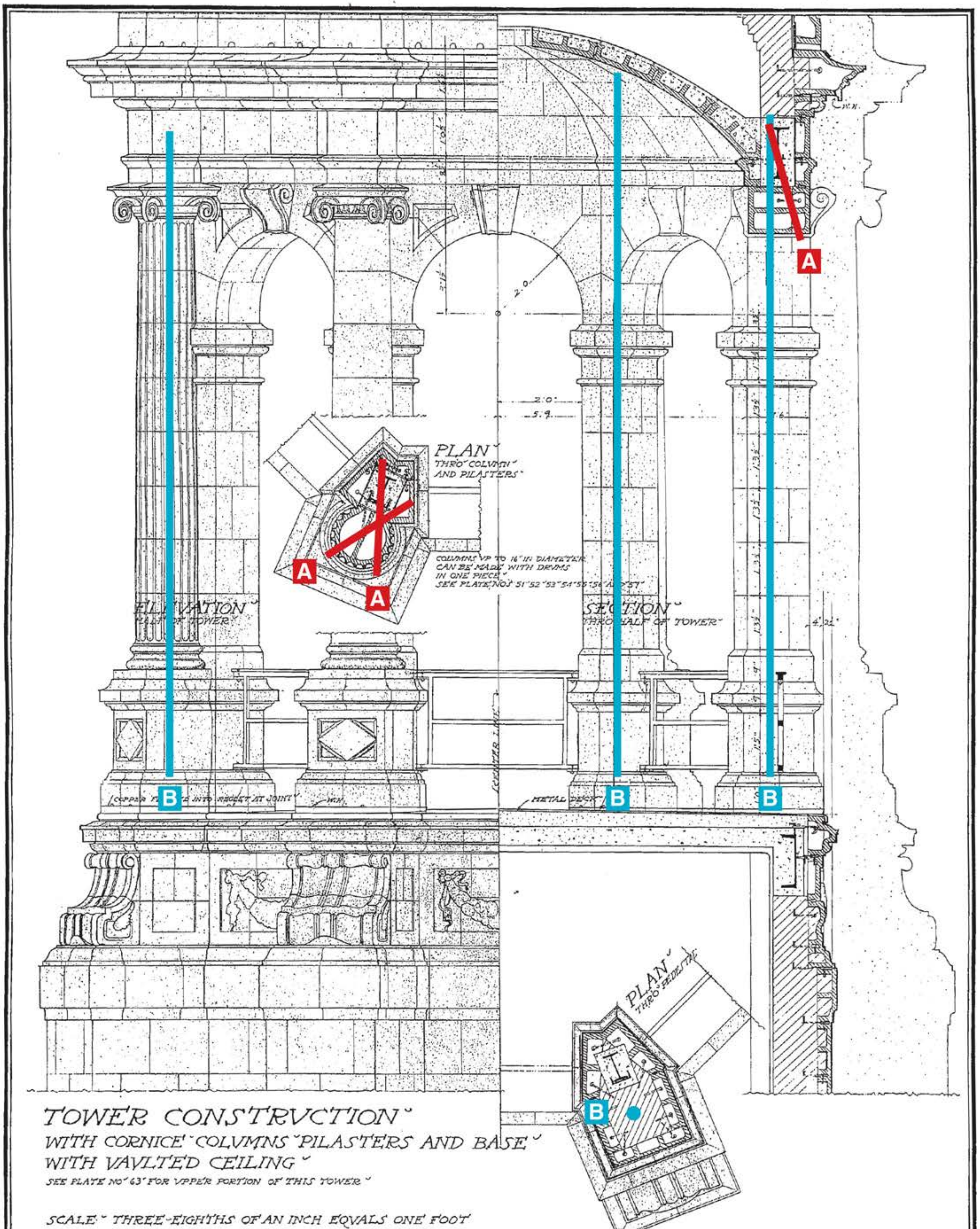
NATIONAL TERRA COTTA SOCIETY · U · S · A · · · PLATE NO · 59



This manual provides general information for use in preliminary selection of a Cintec anchor. **PAGE79**
Final designs must be prepared by Cintec and approved by the project Architect or Engineer of Record.

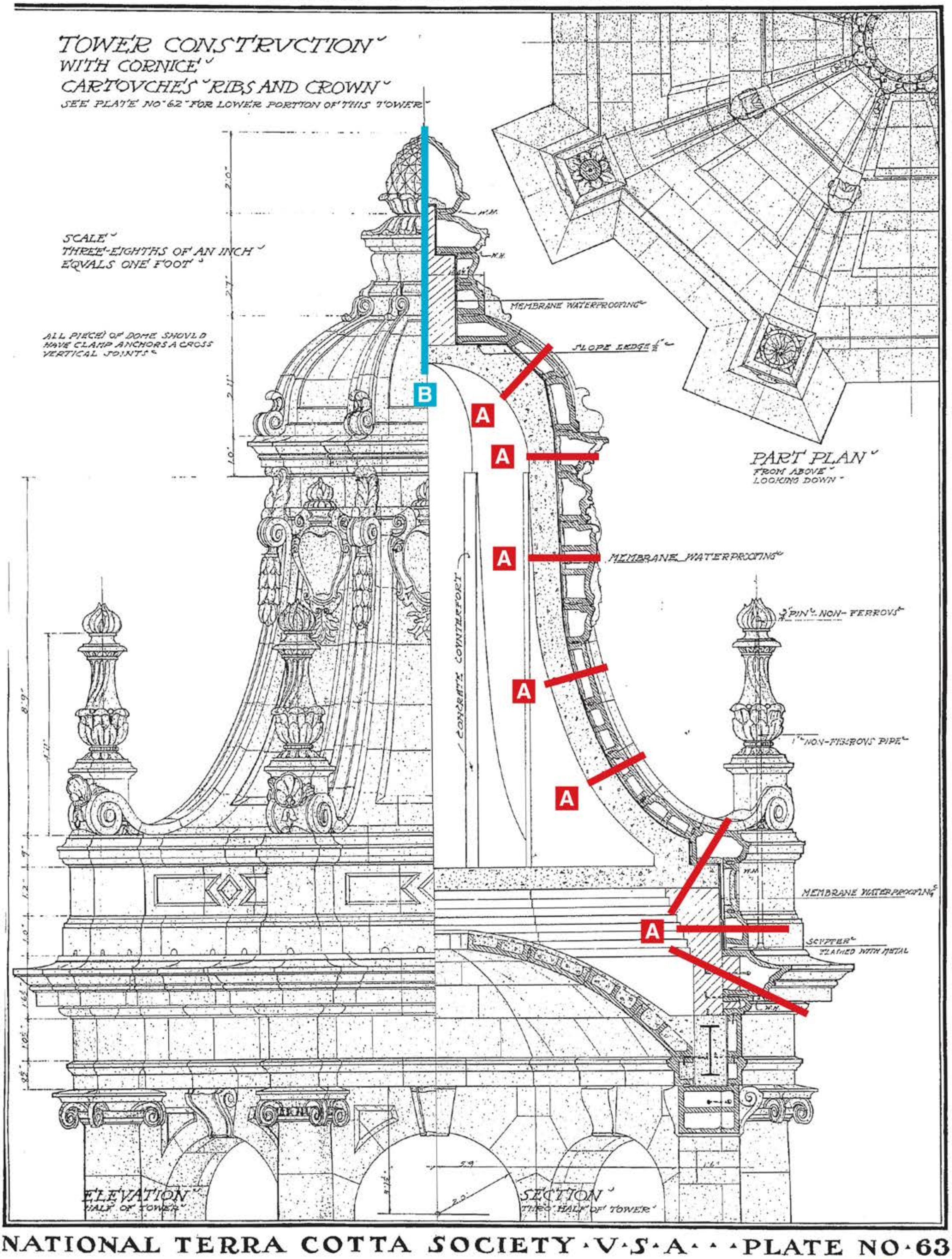


This manual provides general information for use in preliminary selection of a Cintec anchor. **PAGE80**
Final designs must be prepared by Cintec and approved by the project Architect or Engineer of Record.



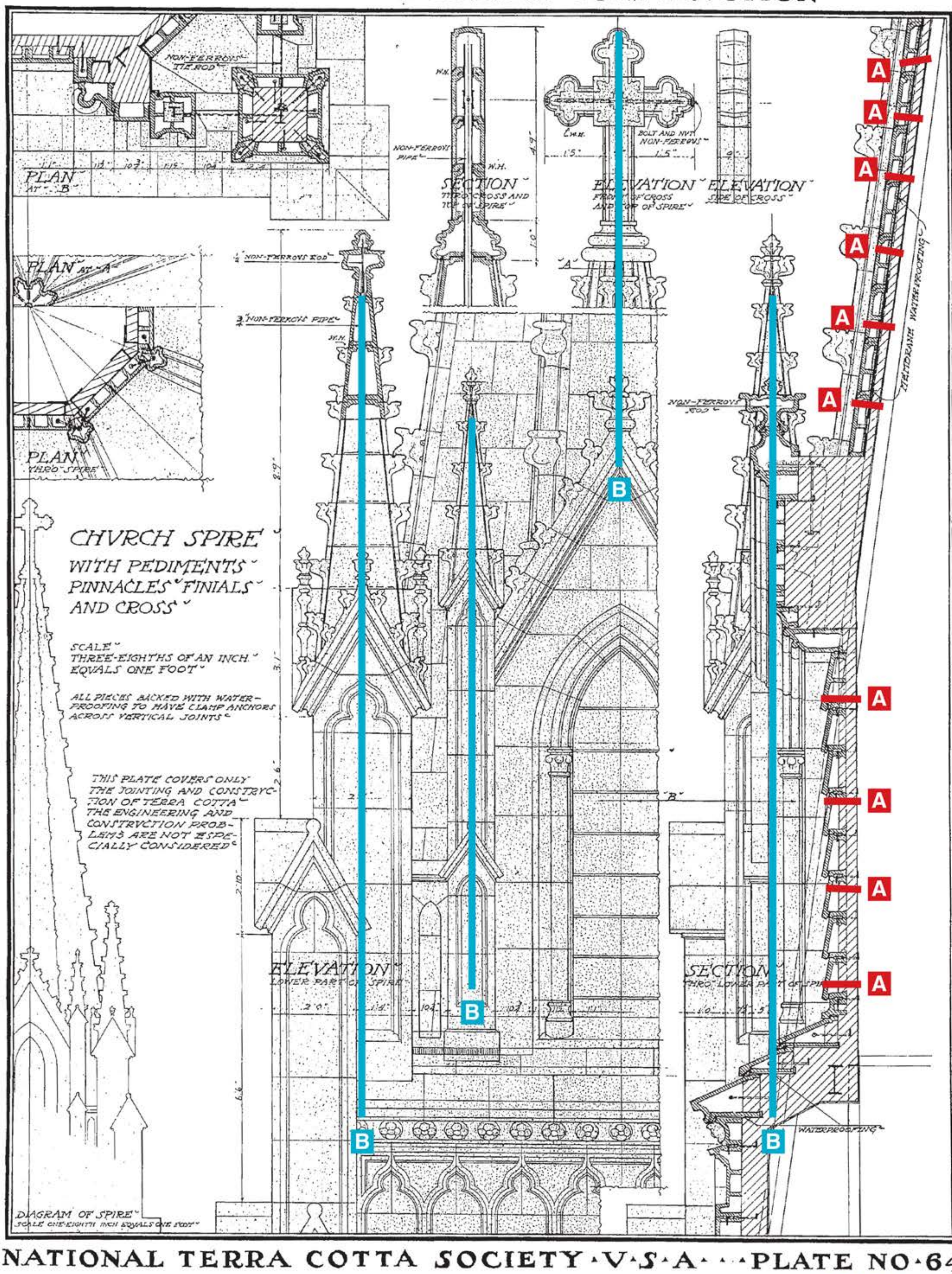
TOWER CONSTRUCTION
WITH CORNICE COLUMNS PILASTERS AND BASE
WITH VAULTED CEILING
SEE PLATE NO 63 FOR UPPER PORTION OF THIS TOWER

SCALE THREE-EIGHTHS OF AN INCH EQUALS ONE FOOT



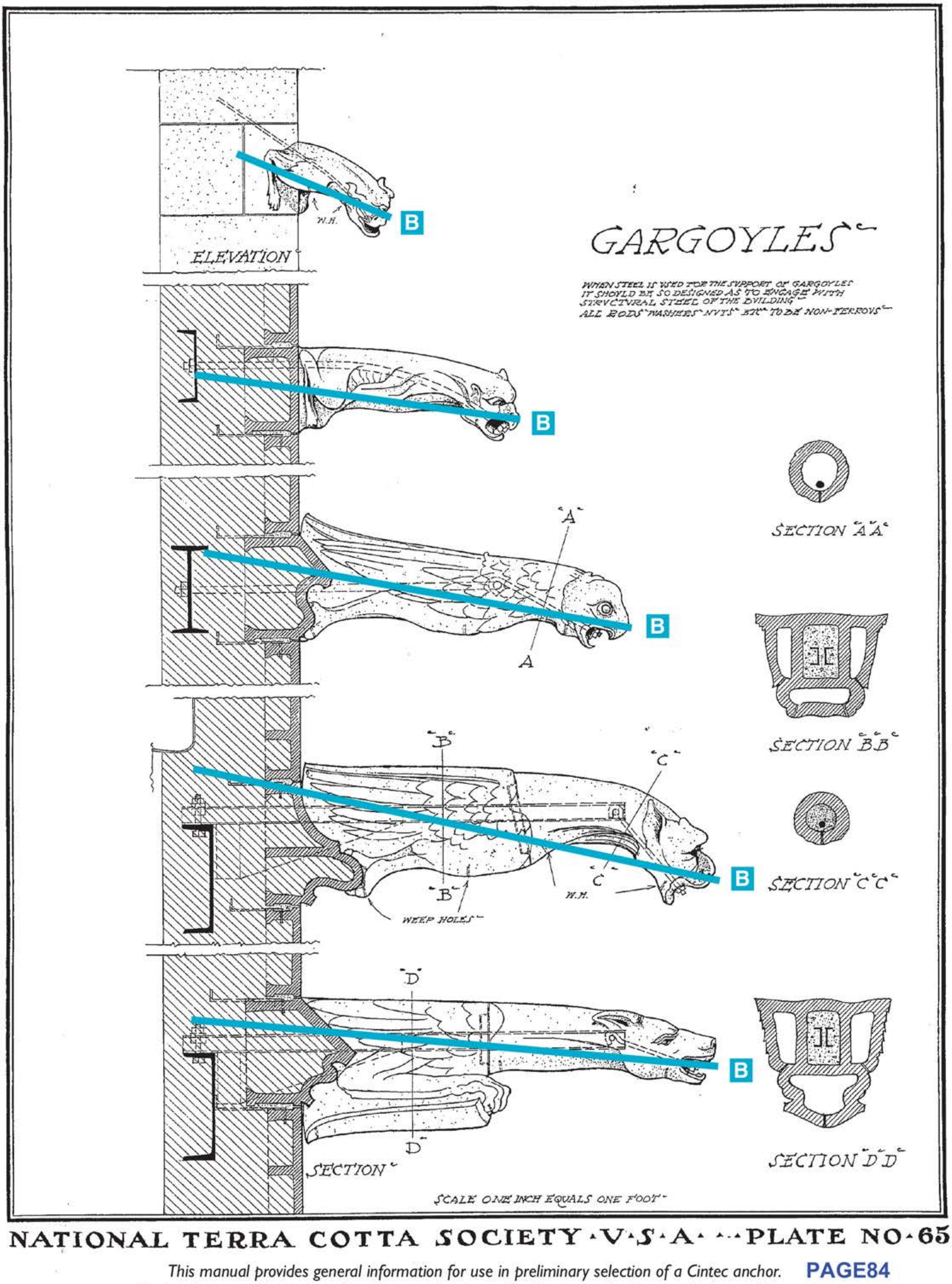
NATIONAL TERRA COTTA SOCIETY · U · S · A · · · PLATE NO · 63

TERRA COTTA · STANDARD CONSTRUCTION



NATIONAL TERRA COTTA SOCIETY · U · S · A · · · PLATE NO · 64

This manual provides general information for use in preliminary selection of a Cintec anchor.
Final designs must be prepared by Cintec and approved by the project Architect or Engineer of Record.


GARGOYLES
WHEN STEEL IS USED FOR THE SUPPORT OF GARGOYLES IT SHOULD BE SO DESIGNED AS TO ENGAGE WITH STRUCTURAL STEEL OF THE BUILDING.
ALL RODS, WASHERS, NUTS, ETC. TO BE NON-FERROUS.
ELEVATION
W.H.
B
B
B
B
B
A
A
SECTION "A" "A"
SECTION "B" "B"
B
B
C
C
W.H.
WEEP HOLES
SECTION "C" "C"
D
D
SECTION "D" "D"
SECTION
SCALE ONE INCH EQUALS ONE FOOT

CINTEC ANCHOR TESTING

New York Schools Construction Authority

TESTING AT:
PS230K
1 ALBERMARLE ROAD, BROOKLYN

AND

PS238K
1633 EAST 8^{TH}, BROOKLYN, NEW YORK

TESTING ENGINEERS:
VERSATILE CONSULTING AND TESTING SERVICES
(JULY 2001)

VERSATILE CONSULTING & TESTING SERVICES, INC.

240-02 66th Avenue
Douglaston, New York 11362 1925
Tel.: (718) 428-5025
Fax: (718) 428-1036
www.versatileconsulting.com

Integrity Is What This Firm Is Built On

Contracts: **PS 230 K and PS 238 K**

Date: **July 9, 2001**

Client: **Cintec North America**

PROFESSIONAL ENGINEER SERVICE

Procedure: **Anchors Installation**

Location: **Parapet Wall**

I, Roman Sorokko, P.E., being duly sworn say: I am a Professional Engineer, (Lic. # 072800) assigned by Hill International, Inc. to conduct the controlled inspection for the subject contract. I have read all provisions of the Building Code of the City of New York, and I am thoroughly familiar with the plans, specifications and standards referred to herein.

As an Engineer of Record, and as directed by Hill International, Inc. and NYC DDC I will personally perform the controlled inspection of the Cintec anchors installation for this project.

I was also directed to generate an engineering calculation in order to confirm the adequacy of the anchors to the design purpose – to secure the terra cotta blocks attached to the exterior surface of the parapet wall (as per as per Item 04525 – Terra Cotta Restoration and Repair, Paragraph 2.2 Anchors).

I certify that I have carefully analyzed the proposed anchors' parameters using a conservative engineering approach (see attachment No. 1) to the best of my knowledge, and I have found that their application will be adequate to the design purpose, and it will be incompliance with the Specifications of the subject contract.

I executed the full scale pull out tests (see Attachment No. 2) for these anchors, and I have found that the achieved results are significantly exceeded the design criteria.

Therefore, I recommend these anchors to be used for the above mentioned contract.

Prep. by Roman Sorokko, P.E.

STATE OF NEW YORK ROMAN SOROKKO 072800 LICENSED PROFESSIONAL ENGINEER

ANCHOR DESCRIPTIONS FOR CORNICE STABILIZATION
AND MODILLION REATTACHMENT

ANCHOR TYPE A
MODILLION REATTACHMENT

1/2" DIA SOLID THREADED SS CINTEC ANCHOR-PLAIN ENDS- IN 1 1/4" DIA HOLE APPROX 24" LONG SOCKED FULL LENGTH. SOCK OVERSIZED TO EXPAND INTO CELL OF NEW T/C UNIT

ANCHOR DESIGN - TENSION

ANCHOR TYPE B
CORNICE STABILIZATION

1 1/2" x 1 1/2" x 1/8" HSS SS CINTEC ANCHOR-PLAIN ENDS -IN 3" DIA HOLE APPROX 30" LONG SOCKED FULL LENGTH. SOCK OVERSIZED TO EXPAND INTO VOID AT FRONT OF EXISTING T/C UNIT.

ALTERNATE DESIGN - EXTEND ANCHOR TO INSIDE FACE OF PARAPET AND PROVIDE SS NUT, WASHER AND BEARING PLARTE

ANCHOR DESIGN - COMBINED BENDING AND SHEAR

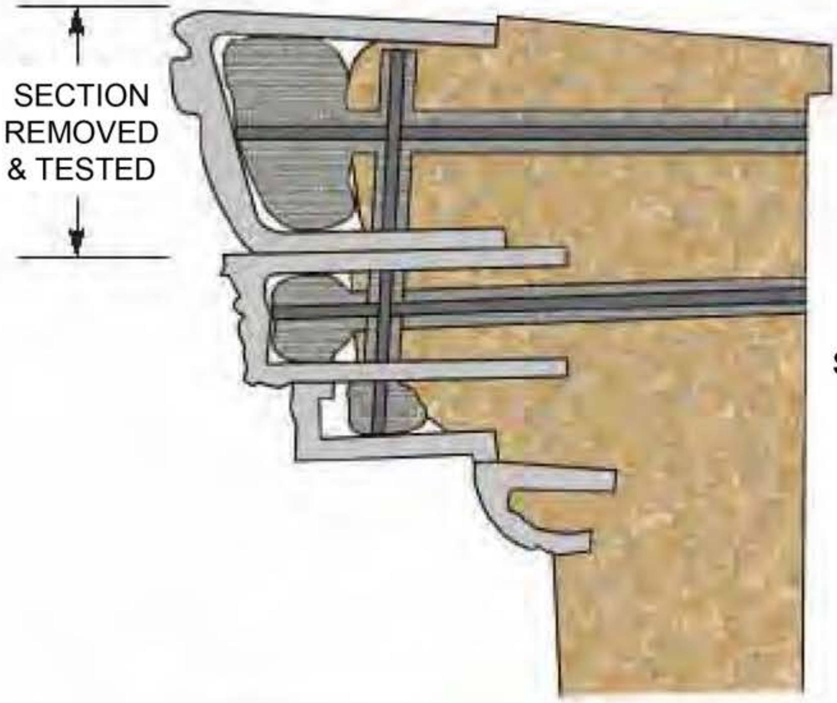
STATE OF NEW YORK
ROMAN SOROKKO
072800
LICENSED PROFESSIONAL ENGINEER

OPTION I
CANTILEVERED DESIGN
(CONSERVATIVE)

Project Name PS 230 & PS258
Location BROOKLYN NEW YORK
Consultant: TAMS CONSULTANTS

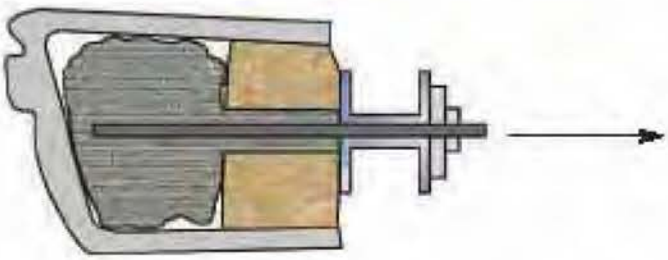
Engineered Grout Injection Anchors by: CINTEC AMERICA INC. Tel 613 225 3381 Fax 613 224 9042 E-mail: rlr@cintec.com	Project #: By: AZ Date: JANUARY 2001
Product Engineering By: JOKINEN ENGINEERING SERVICES Tel 905 333 1079 Fax 905 333 3659 E-mail: eric.jokinen@sympatico.com	SK 2A DRWG #: | 0 REV. #

CINTEC TERRA COTTA SOLUTIONS



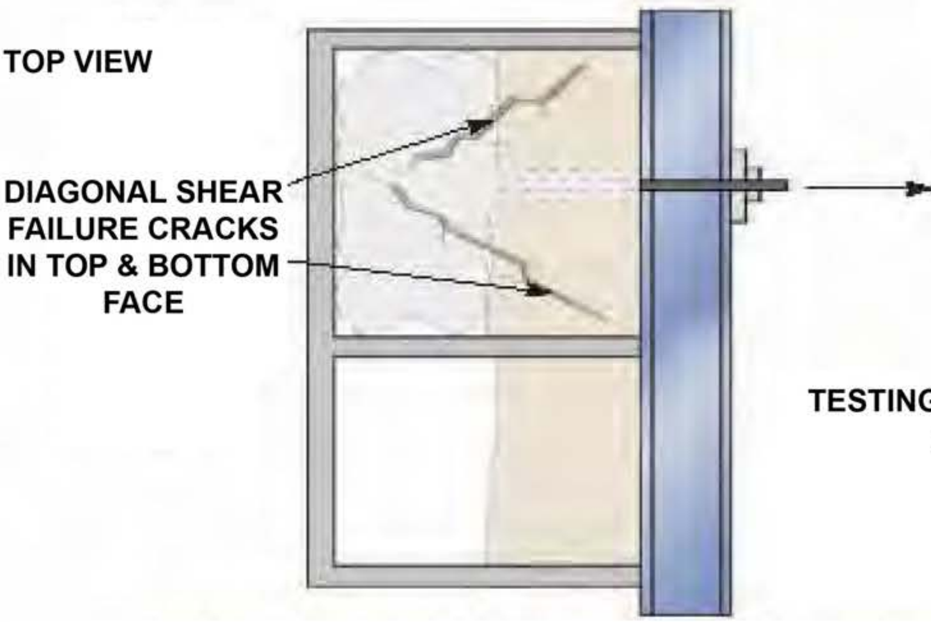
CINTEC SOLUTION AS BUILT

SECTION

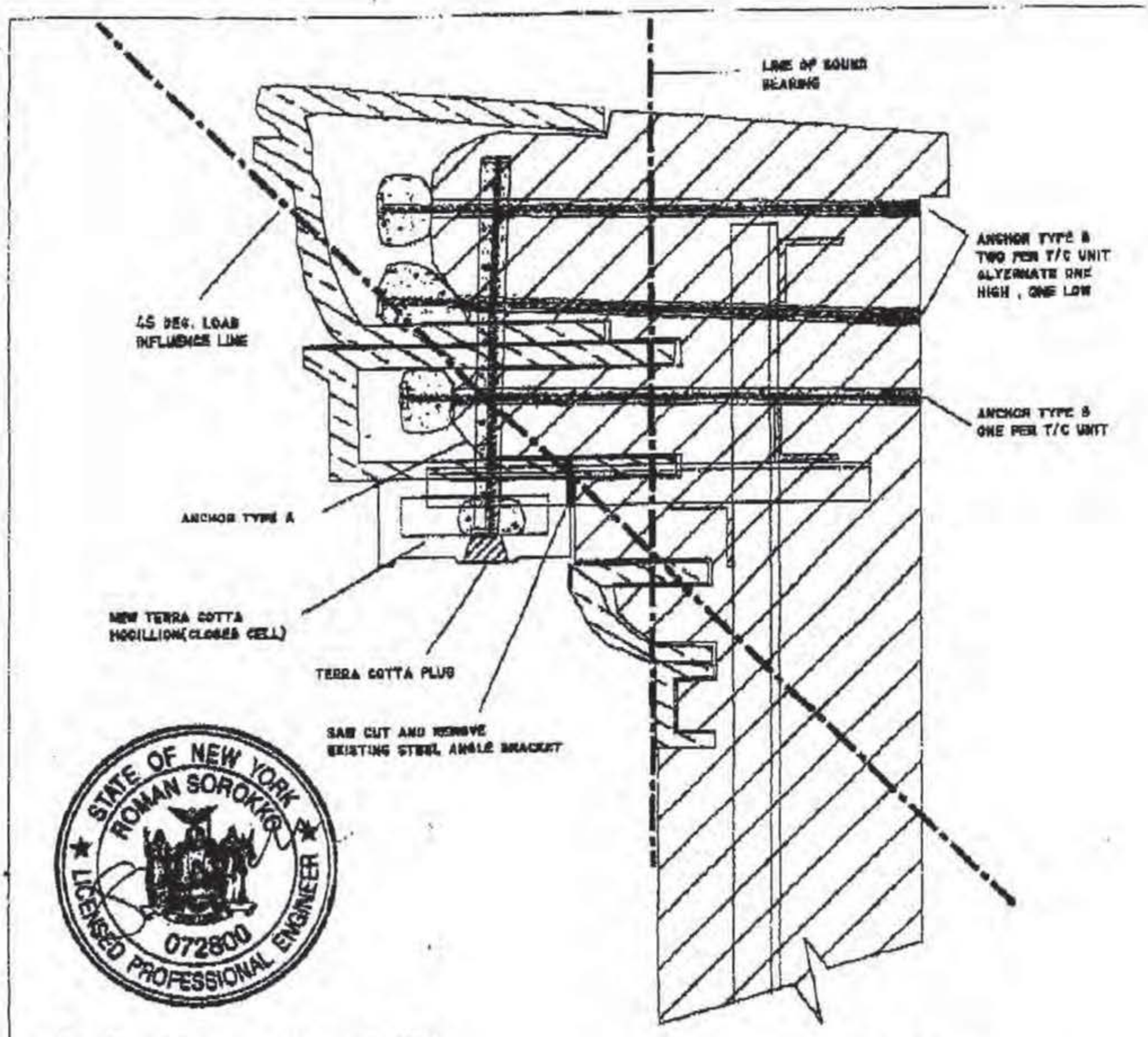


FULL SCALE TESTING

TOP VIEW



TESTING DETAILS FOR NEW YORK SCHOOLS CONSTRUCTION AUTHORITY PS 230 K



Project Name PS 230 & PS 258

Location BROOKLYN, NEW YORK

Consultant: TAMS CONSULTANTS, INC.

CORNICE STABILIZATION
MODILLION REPLACEMENT ONLY

Engineered Grout Injection Anchors by: CINTEC AMERICA INC. Tel 613 225 3381 Fax 613 224 9042 E-mail: rlr@cintec.com	Project #: By: AZ Date: Dec 14/2000
Product Engineering By: JOKINEN ENGINEERING SERVICES JES C129 Tel 905 333 1079 Fax 905 333 3650 E-mail: eric.jokinen@sympatico.com	SK 1 DRWG #: | 1 REV. #

ANCHOR DESCRIPTIONS FOR CORNICE STABILIZATION
AND MODILLION REATTACHMENT

ANCHOR TYPE A
MODILLION REATTACHMENT

1/2" DIA SOLID THREADED SS CINTEC ANCHOR-
PLAIN ENDS- IN 1 1/4" DIA HOLE APPROX
24" LONG SOCKED FULL LENGTH. SOCK
OVERSIZED TO EXPAND INTO CELL OF NEW
T/C UNIT

ANCHOR DESIGN - TENSION

ANCHOR TYPE B
CORNICE STABILIZATION

3/4" DIA SOLID THREADED SS CINTEC ANCHOR-
PLAIN ENDS -IN 2" DIA HOLE APPROX 30" LONG
SOCKED FULL LENGTH. SOCK OVERSIZED
TO EXPAND INTO VOID AT FRONT
OF EXISTING T/C UNIT.

ALTERNATE DESIGN - EXTEND ANCHOR TO
INSIDE FACE OF PARAPET AND PROVIDE
SS NUT, WASHER AND BEARING FLARTE

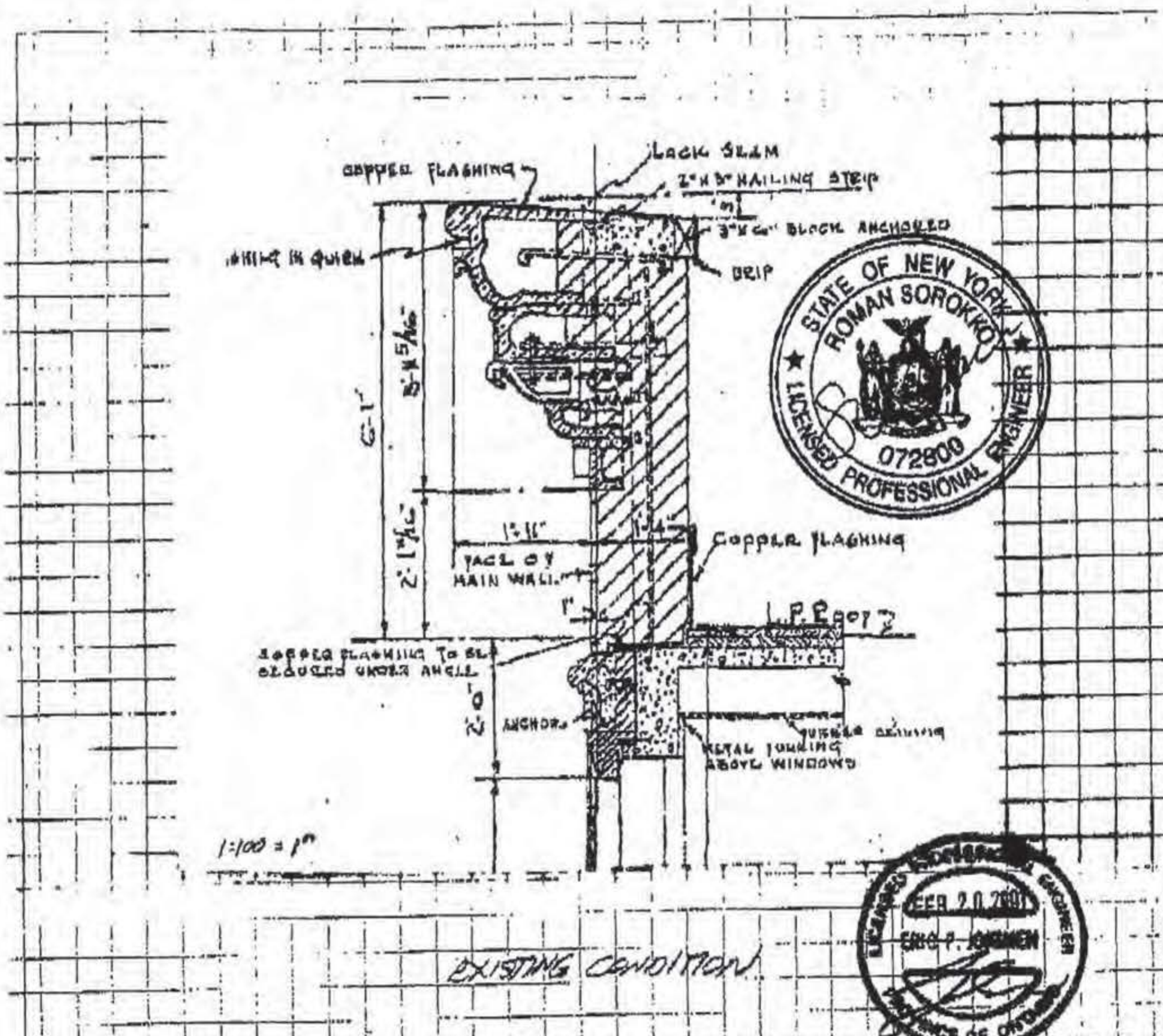
ANCHOR DESIGN - COMBINED PULL-OUT AND SHEAR

STATE OF NEW YORK
ROMAN SOROKKO
072800
LICENSED PROFESSIONAL ENGINEER

OPTION 2
CORBELLED DESIGN
(LESS CONSERVATIVE)

Project Name PS 230 & PS236
Location BROOKLYN NEW YORK
Consultant: TAMS CONSULTANTS

Engineered Grout Injection Anchors by: CINTEC AMERICA INC. Tel 613 225 3381 Fax 613 224 9042 E-mail: rlr@cintec.com	Project #: By: AZ Date: JANUARY 2001
Product Engineering By: JOKINEN ENGINEERING SERVICES Tel 905 333 1079 Fax 905 333 3659 E-mail: eric.jokinen@sympatico.com	SK 2B — DRWG #: / 0 — REV. #



Project Name: PS 230 & PS 238
Location BROOKLYN, NEW YORK
Consultant: TAMS CONSULTANTS, INC.

DESIGN CALCULATIONS
CORNICE / PARAPET

Engineered Grout Injection Anchors by:

CINTEC AMERICA INC.

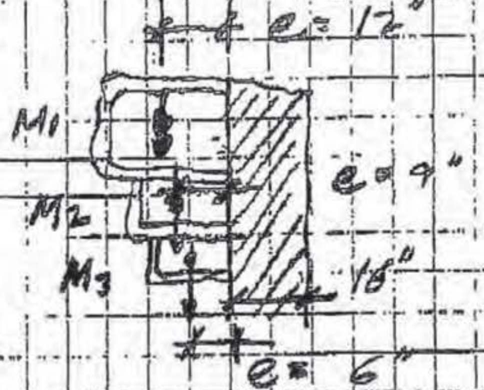
613 225 3381 Fax 613 224 9042 E-mail: dr@cintec.com

Product Engineering By: JOKINEN ENGINEERING SERVICES
Tel 905 333 1079 Fax 905 333 3650 E-mail: eric.jokinen@sympatico.com

JES C129

Project #:
By: AZ
Date: Dec 14/2000

DE 1	0
DRWG #:	REV. #



STATE OF NEW YORK
ROMAN SOROKKO
072800
LICENSED PROFESSIONAL ENGINEER

(L)

M1: 2' x 1.5' x 2.5 @ 100 PCF = 750#

M2: 1' x 1.5' x 3.0 @ 100 PCF = 450#

M3: 1' x 0.67' x 2.0 @ 50 PCF = 100#

MAT'L: ANSI 304 SS
F_y = 29,000 PSI } STEEL
f'_c = 5000 PSI GROUT
f'_b = 300 PSI BRICK SUBSTRATE

ERIC P. JOKINEN
[illegible]
PROFESSIONAL ENGINEER
PROVINCE OF ONTARIO

Project Name PS 230 & PS 238
Location BROOKLYN, NEW YORK
Consultant: TAMS CONSULTANTS, INC.

DESIGN CALCULATIONS
CORNICE & [illegible]

Engineered Grout Injection Anchors by:
CINTEC AMERICA INC.
613 225 3361 Fax 613 224 9042 E-mail: rn@cintec.com

Product Engineering By: JOKINEN ENGINEERING SERVICES
Tel 905 333 1079 Fax 905 333 3659 E-mail: eric.jokinen@sympatico.com

JES C129

Project #:
By: AZ
Date: Dec 14/2000
DRWG #: DE 2
REV. #: 0

OPTION 1: CANTILEVER DESIGN (CONSERVATIVE)

BLOCK M1: 750#/2 ANCHORS

2 anchors / block

$1\frac{1}{2} \times 1\frac{1}{2} \times \frac{1}{8}$ anchor body $A = 0.531\ in^2$

#56 $S = 0.266\ in^3$

Shear

$V = \frac{750}{2} = 375\,\#$

$f_v = \frac{V \times 2.0}{0.531} = 1412\ psi < 0.4\,F_y$

$M = \frac{750}{2} \times 12" = 4500\ in\text{-}lb$

$f_b = M/S = \frac{4500}{0.266} = 16917 < 0.66\,F_y$

STATE OF NEW YORK
ROMAN SOROKKO
072800
LICENSED PROFESSIONAL ENGINEER

LICENSED PROFESSIONAL ENGINEER
FEB 20 2001
ERIC P. JOKINEN
PROVINCE OF ONTARIO

Project Name: PS 230 & PS 238
Location: BROOKLYN, NEW YORK
Consultant: TAMS CONSULTANTS, INC.

DESIGN CALCULATIONS

Engineered Grout Injection Anchors by: CINTEC AMERICA INC. 613-225-5381 Fax 613-224-5042 E-mail: [illegible]		Project #:
		By: AZ
		Date: Dec 14/2000
Product Engineering By: JOKINEN ENGINEERING SERVICES Tel 905 333 1079 Fax 905 333 3659 E-mail: eric.jokinen@sympatico.com	JES C129	DE 3 / DRWG #: 0 / REV. #

OPTION 1: CANTILEVER (CONSERVATIVE)

BLOCK M1 (CONT'D)

CHECK BRG ON BRICK

ASSUME 3" φ DIA HOLE

BRG ON ½ CIRCUMF.

STATE OF NEW YORK ROMAN SOROKKO LICENSED PROFESSIONAL ENGINEER 072800

EMBEDMENT = t − 2" = 16" − 2" = 14"

$S_b = \frac{3 \times 3.14}{2} \times \frac{14^2}{6} = 154 \text{ in}^3$

$A_b = \frac{3 \times 3.14}{2} \times 14 = 66 \text{ in}^2$

Moment about centroid of brick brg area

$M = \frac{e}{12} + \frac{14}{2} = 19" \times 375\# = 7125$ in-lb

$f_{bend} = \frac{7125}{154} = 46$ psi

$f_{brg} = \frac{375}{66} = 6$ psi

$\Sigma = 52$ psi < 300 psi ALLOWABLE

Project Name: PS 230 & PS 238

Location: BROOKLYN, NEW YORK

Consultant: TAMS CONSULTANTS, INC.

FEB 2 0 2001 ERIC P. JOKINEN

DESIGN CALCULATIONS

Engineered Grout Injection Anchors by:

CINTEC AMERICA INC.

613 225 3381 Fax 613 224 9042 E-mail: rlr@cintec.com

Product Engineering By: JOKINEN ENGINEERING SERVICES

Tel 905 333 1079 Fax 905 333 5659 E-mail: eric.jokinen@sympatico.com

JES C129

Project #:	
By: AZ	
Date: Dec 14/2000	
DE 4	0
DRWG #:	REV. #

OPTION 1 : CANTILEVER

BLOCK M2:

TRY 1 ANCHOR / BLOCK

1/2 x 1/2 x 8 in 3" HOLE - EMBED 14"

M_c = 450 x 9 = 4050 < M_c (BLOCK 1) ∴ OK

M_{BRG} = 450 x (9 + 7) = 7200 in-lb ≈ M_{brg} (BLOCK 1)

∴ OK

USE SAME DESIGN AS

BLOCK 1 EXCEPT 1 ANCHOR / BLOCK

BLOCK M3 IN TENSION

P = 100#/blk 1/2"φ THRD ROD A_{net} = 0.11 in²

P_{allow} = 0.11 x 29000 x 0.6 = 1900# OK

Pull out 1 1/4"φ HOLE x 12" EMBED @ 65 PSI BOND

P_a = 3060# OK

END OPTION (1)

Project Name PS 230 & PS 238

Location BROOKLYN, NEW YORK

Consultant: TAMS CONSULTANTS, INC.

DESIGN CALCULATIONS

STATE OF NEW YORK · ROMAN SOROKKO · LICENSED PROFESSIONAL ENGINEER · 072800

REGISTERED PROFESSIONAL ENGINEER · FEB 20 2001 · ERIC JOKINEN · PROVINCE OF ONTARIO

Engineered Grout Injection Anchors by:

CINTEC AMERICA INC.

613 225 3381 Fax 613 224 9042 E-mail: rlr@cintec.com

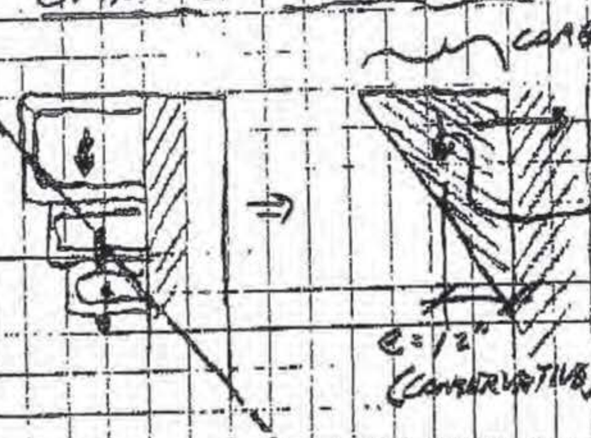
Product Engineering By: JOKINEN ENGINEERING SERVICES

Tel 905 333 1079 Fax 905 333 3659 E-mail: eric.jokinen@sympatico.com

JES C129

Project #:	
By: AZ	
Date: Dec 14/2000	
DE 5	0
DRWG #:	REV. #

OPTION 2: CORBELLED



$P = M1 + M2 + M3$
$= 750 + 450 + 100^{\#}$
$= 1300^{\#}$

STATE OF NEW YORK
ROMAN SOROKKO
072800
LICENSED PROFESSIONAL ENGINEER

$M_c = 12 \times 1300 = 15600$ in-lb

$P = \frac{M}{d} = \frac{15600}{16} = 975^{\#}$ PULLOUT ON 1 ANCHOR

TRY 3/4"Ø in 1 1/4"Ø HOLE - 14" EMBED

STEEL: $P_a = 0.25 \times 29000 \times 0.6 = 4350^{\#} < 975^{\#}$

BOND: $P_a = 1.5\pi \times 12" \times 65\ psi = 3673^{\#} < 975^{\#}$

∴ OK

BLOCK M3 HANGER (AS OPTION 1 DESIGN)

Project Name PS 230 & PS 238

Location BROOKLYN, NEW YORK

Consultant: TAMS CONSULTANTS, INC.

DESIGN, CALCU[LATIONS]

LICENSED PROFESSIONAL ENGINEER
FEB 2 0 2001
ERIC JOKINEN
PROVINCE OF ONTARIO

Engineered Grout Injection Anchors by:

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613 228 3381 Fax 613 224 9042 E-mail: rlr@cintec.com

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Tel 905 333 1079 Fax 905 333 3659 E-mail: eric.jokinen@sympatico.com

JES C129

Project

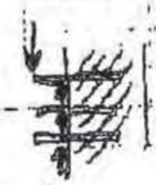
By AZ

Date: Dec 14/2000

DE 6	0
DRWG #:	REV. #

OPTION 2: CORBELLED

CHECK SHEAR IN ANCHORS @ PARAPET EXT. FACE



3 - 3/4"φ THRD ROD DOWELS

$V_{allow} = \frac{0.25 \times 29000 \times 0.4}{1.33} = 2180^{\#}$/anchor

> 1300# TOTAL REQD
∴ OK

END OPTION (2)

STATE OF NEW YORK
ROMAN SOROKKO
072800
LICENSED PROFESSIONAL ENGINEER

LICENSED PROFESSIONAL ENGINEER
FEB 20 2001
ERIC P. JOKINEN
PROVINCE OF ONTARIO

Project Name: PS 230 & PS 238

Location: BROOKLYN, NEW YORK

Consultant: TAMS CONSULTANTS, INC.

DESIGN CALCULATIONS

Engineered Grout Injection Anchors by:

CINTEC AMERICA INC.

Tel 613 224 3781 Fax 613 224 9042 E-mail: cintec@cintec.com

Product Engineering By: JOKINEN ENGINEERING SERVICES

Tel 905 333 1079 Fax 905 333 3659 E-mail: eric.jokinen@sympatico.com

JES C129

Project #:

By: AZ

Date: Dec 14/2000

DRWG #:	REV. #
DE 7	0

ANCHORS TESTING PROGRAM

Project: PS 230K

Prepared for Hill International, Inc.

by Roman Sorokko, P.E.
/Lic. No. 072800

JUNE 2001

THE CEMENTITIOUS INJECTED GROUT ANCHORS TESTING PROGRAM

I, Roman Sorokko, being duly sworn say: I am a Professional Engineer, (Lic. #072800) assigned by Hill International, Inc. to conduct the anchor testing for the Project E3000.

I have read all provisions of the Building Code of the City of New York, and the Project Specifications, and I am thoroughly familiar with the plans, and standards referred to herein, and I am thoroughly familiar with all the responsibilities for the inspection of the subject item.

1. Introduction

As per NYC DDC request, and as directed by Hill International, Inc. we performed the pull out test of the steel anchors fabricated by Cintec America Inc. The purpose of the test is to verify the anchors' design parameters as per Item 04525 - Terra Cotta Restoration and Repair, Paragraph 2.2 Anchors.

2. Equipment

20 tons hydraulic jack with center hole cylinder, gage 1000 psi, hydraulic hand pump, loading valve.

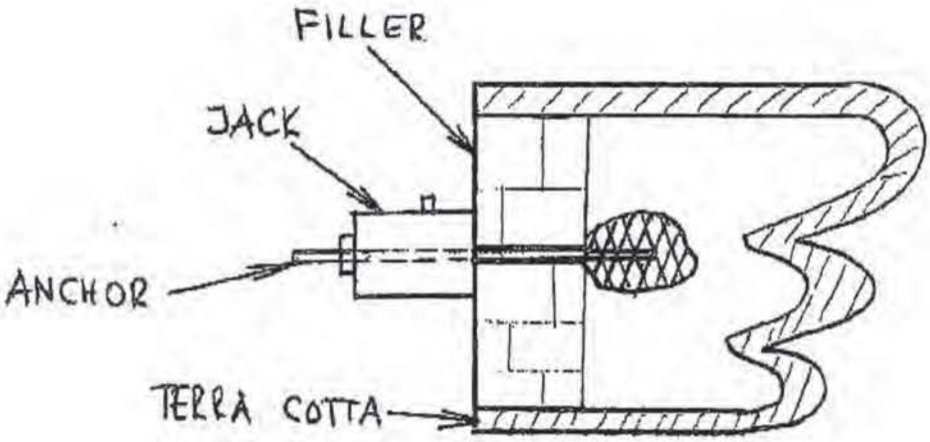
3. Procedure

One June 18, 2001 the anchors Type A and Type B were installed by the representatives of Cintec America Inc. This installation was also a part of the Contractor's training program. Two Type A anchors (1/2" in diameter) designated for the testing were placed into the pies of terra cotta which was previously removed from the building. One designated for testing Type B anchor 1.5" x 1.5" x 1/8" HSS shape was installed into the parapet wall.

4. Test Results

TEST No.1

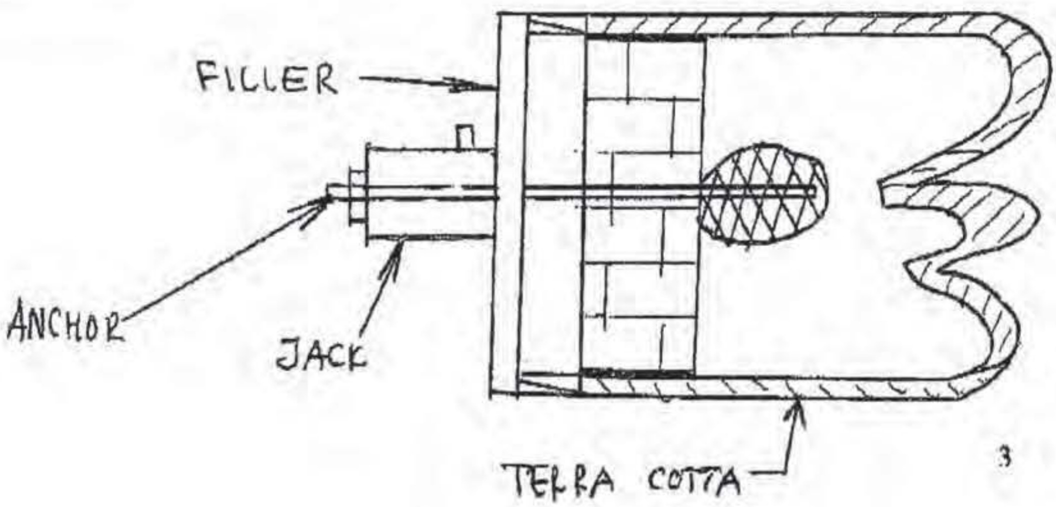
Type A anchors were tested under two different schemes. During the first setting the jack was placed directly on top of the terra cotta's masonry filler (See Photo No. 1 and Sketch below). Therefore, the forces developed by the hydraulic jack were transformed into the anchor's expanded part through the brick masonry filer. Hence, the terra cotta, as well as the joints between the terra cotta and the filler were not stressed.



Under this format the Type A anchor was loaded up to 4,690 lbs or 2.3 tons (equivalent of 1,000 psi reading). The load was gradually applied in steps of 100 psi increment.

The tested anchor sustained the maximum load of 4,690 lbs or 2.3 tons during 15 minutes.

During the second test the same previously tested Type A anchor was loaded in such a way that the terra cotta was under the compression stress from the hydraulic jack. Therefore the pull out forces were developed along the joint between the terra cotta and the masonry filler (see Photos No. 2 and 3 and Sketch below).



The anchor was gradually loaded up to 2,580 or 1.3 tons which equivalent to 550 psi reading. At the point the joint between the terra cotta and the masonry filler failed (see Photos No 4, 5, 6 and 7).

TEST No. 3

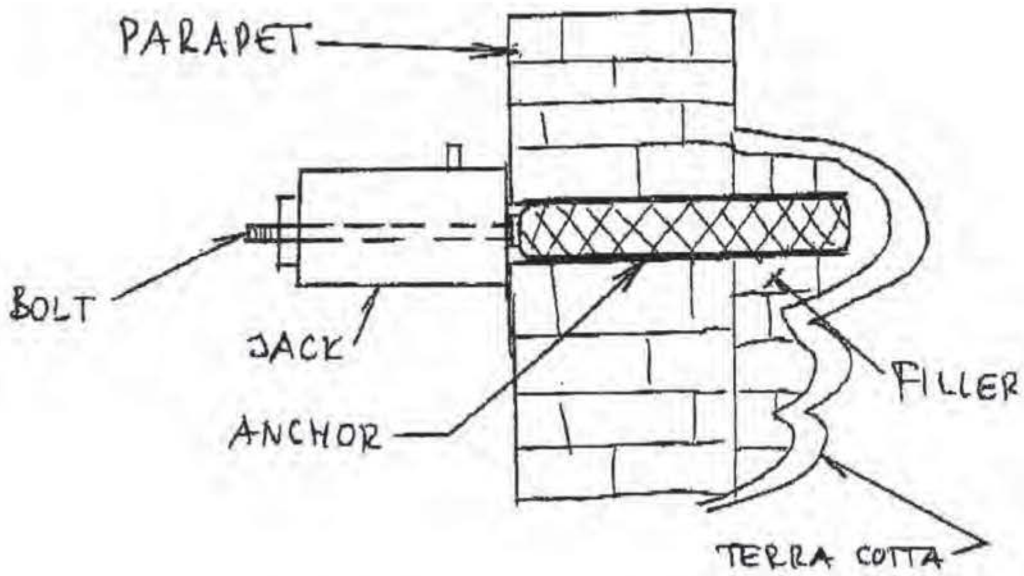
The second Type A anchor was loaded similar to the TEST No. 2 - pull out forces were applied to the joint between the terra cotta and the masonry filler.

The joint failed under the load of 3,987 lbs or 2.0 tons (equivalent to 850 psi reading).

TEST No. 4

The anchor Type B (installed into the brick masonry parapet wall and partly inserted into the terra cotta) was tested under the similar setting to the TEST No. 2 and 3 as shown on Sketch below.

For the testing purpose the steel bolt, 3/4" in diameter, was welded to the anchor's cover plate.



The anchor was gradually loaded up to 2,814 lbs or 1.4 tons (equivalent to 600 psi reading). The anchor has sustained this load for 15 minutes.

5. Conclusion

Therefore, the results of the performed testing program can be summarized as follows:

Anchor Type A

1. Pull out forces acting between the anchor and the terra cotta's masonry filler - the system sustained the load of 4,690 lbs or 2.3 tons.

2. Pull out forces acting along the joint between the terra cotta and the filler - The system failed under the laod of 2,580 or 1.3 tons and 3,987 lbs or 2.0 tons (average 3,284 lbs or 1.64 tons)

Anchor Type B

Pull out forces acting along the anchor and the masonry parapet wall - the system sustained the load of 2,814 lbs or 1.4 tons.

I certify that I have carefully performed this test to the best of my knowledge, and I have accurately reported all the obtained results.

Prep. bv Roman Sorokko

STATE OF NEW YORK
ROMAN SOROKKO
072800
LICENSED PROFESSIONAL ENGINEER

A CONSERVATION STUDY OF

A Terra-Cotta Building

Circa 1917-1918

By: Professor Martin E. Weaver, AA Dipl

A study of a Terra-Cotta Building
By Professor Martin E. Weaver, AA Dipl

INTRODUCTION

This Terra-Cotta Building was built in 1917-18 as the Norlite Building and was designed by Richards and Abra with C.P. Meredith.

From an examination of copies of some of the original drawings for the building, it was apparent that the building was constructed with a reinforced concrete frame and floors; and was clad on its North with off-white glazed terra-cotta cladding. The terra-cotta cladding was returned round the East and West façade for one bay, and small, terra-cotta clad towers were formed and a half storey's high above the main parapet copper-clad domes; and the parapet was decorated with two free-standing terra-cotta urns on bases or acroteria. Both the domes and the urns have disappeared.

The first studies on the Building commenced when Martin Weaver was commissoned to carry out a brief examination of the North or main terra-cotta fa'çade in November 1993.

Martin Weaver had initially been requested to advise on the repair of the terra-cotta cladding on one of the piers at the 7th and 8th storey's (Bay 4 numbering from the East) and to make a proposal for further studies if these should be found necessary. In the course of the initial study Martin Weaver found that parts of the terra-cotta cornices on the East and West towers were in a dangerous state and in need of immediate stabilization. The risk of injury to pedestrians on the sidewalks beneath was in fact so serious that barriers need to be erected immediately. These observations were forwarded directly to the client.

The terra-cotta work was found to be generally cracked in a number of places and bowed and cracked away from the main structure in others. Mortar, stucco and other repairs were also showing signs of failure.

THE CONDITION SURVEY

Martin Weaver was thus commissioned to make the study, and the condition survey was carried out from a personnel basket suspended at the end of the cable from the jib of 110 ton mobile crane. The survey was carried out in a very poor weather with snow and extremely cold windy conditions in December 1993. The temperature with the wind-chill factor was often lower than -25°C.

Parts of the structure were obscured by snow and thus could not be surveyed. Every part of the exposed external surface of the terra-cotta work was examined closely and loose and dangerous fragments were removed from the building wherever possible.

As a result of the writers' immediate observations a second emergency report and recommendations were issued. The object of these recommended works was to remove risk of injury to the public which might be caused by falling fragments of terra-cotta.

A Study of a Terra-Cotta Building
By Professor Martin E. Weaver, AA Dipl

Observations

The problems of the terra-cotta cladding of the Building are typical of such structures and materials of the period of the golden era of architectural terra-cotta from the early 1900's to the 1920's.

It may be helpful to list the major deteroration categories which were present in this case:

1. Over a long period of time a combination of initial shrinkage and long term ''frame-shortening'' of the reinforced concrete frame of the building has tended to transfer loads onto the relatively thin terra-cotta cladding. The terra-cotta units have this brittle walls and fail in compression, usually cracking horizontally at their mid-points or suffering from spalls at their loaded upper edges and sometimes lower edges (see for example areas W7-8); the sides of the tera-cotta units usually tend to have a slight recess immediately behind the outer edge, the resulting projections over and under the bed joints then tend to receive the concentrated loads; units in cladding which is loaded in this way may also buckle outwards and may cause extremely dangerous conditions to develop if the anchors are corroded; or are insufficiently numerous or if they break out of the brittle terra-cotta. This might also be a part of the problem with the cornices on the East and West Towers.

2. Leakage of water into the wall, usually from open joints in skyward-facing surfaces, can lead to freezing water within the wall and to the terra-cotta units being forced off the walls; or the water can cause corrosion in hidden steel anchors and rods which were used to tie the cladding back top and the back-up brickwork or to the concrete of the frame, columns, or edge beams; in which cases the damage was probably also the main cause of the failure of the cornices on the East and West Towers.

3. Localized spalling and exfoliation of glaze/slip coats caused by water being trapped in the terra-cotta body behind the latter;

4. Surface cracquleure on some blocks where ''lack of fit'' or differences in thermal expansion coefficients cause the body to shrink or expand more, and more quickly than the glaze/slip combination;

5. Extensive failures of joints; failures of ineffective repairs to jointing and pointing and failures of repairs to previously damaged terra-cotta have all contributed substantialy to the entry of water behind the terra-cotta cladding where it can freeze or cause corrosion in hidden steel anchors;

6. Extensive failures of cementitious repairs where original balconies or terra-cotta and ironwork have been removed (8^{th} storey North façade) have contributed to the entry of water with the results noted in the above case; there was also a failure to remove all of the associated with the balconies and this has led to continuing corrosion causing expansion, cracking of the terra-cotta and renders, and extensive rust staining.

REMEDIALACTION AND RESTORATION MEASURES

The tops of the two towers should be carefully dismantled after first recording them and numbering all the terra-cotta units. The terra-cotta work should be dismantled at least to the level of the base of the cornices as indicated on the drawings. After the security of the masonry has been established and a sound level has been reacted, the terra-cotta and the brick back-up masonry can be rebuilt.

All corroded steel anchors, cramps, ties and other terra-cotta cladding-attachment devices must be carefully removed and replaced with appropriately designed replacements in stainless steel (AISI Type 304).

All shattered and irreparable terra-cotta units should be replaced using new units of fine-faced pre-cast concrete or fiber reinforced plastic carefully fabricated to match original dimensions and surface finishes including fine ribbing or ''tooling''. It would probably not be practical to obtain the small number of replacement units required, using actual matching terra-cotta. Delivery times for terra-cotta would normally be a major problem.

The entire terra-cotta cladding must be tied back to the back-up masonry in such a way that the load of the cladding is transferred back onto the reinforced concrete edge beams on the floor slabs. This tying back should be effected by the use of specifically designed Cintec grout injection anchors, which are the only type that can effectively be used in this case.

Once the cladding had been tied back and effectively stabilized, all the mortar joints in the terra-cotta work should be carefully cut out and the caulking or sealants removed. This work of mortar removal must be carried out with great care using small diameter diamond saws (120mm diameter) and specially designed diamond impregnated router bits. Both should be used with pneumatically powered tools with attached dust extraction intakes. Special care should be taken to ensure that the terra-cotta blocks are not damaged by over-cutting or ''Straightening'' of bed joints or by over-cutting or ''nicking'' at the top and bottom of vertical joints.

Replace all jointing and bedding mortar with a mortar mix of 1;1;6 p,b,v. (non staining white Portland cement) hydrated lime sand with 16% entrained air obtained by thoroughly machine mixing for approximately 8-10 minutes.

The purpose of the entrained air is to confer and freeze/thaw cycle resistance.

One bed joint at each storey immediately at or below the floor slab should not be pointed with mortar but should be pointed with a high quality dymeric or similar caulking compound or sealant, to produce a soft compressible joint, thus preventing compression of the panels of cladding between floor slabs.

Prior to any cleaning of the masonry, all corroding steel and ironwork, bolt stubs, and redundant electrical conduits, junction boxes and brackets should be removed from the Masonry and the holes made good to match surrounding material. Embedded bolts and fragments of bars or rails should be drilled out using a diamond-tipped coring bit of slightly larger diameter. The resulting hole should be plugged with a limestone core in limestone and with a Jahn Terra-Cotta Restoration Mortar in the terra-cotta. The latter shall be carefully matched to the original color and texture of the terra-cotta. Spalls in the terra-cotta and areas of failing cementious repairs in the terra-cotta should be carefully cut out as necessary and should also be repaired with matching Jahn Terra-Cotta Restoration Mortar.

Slight losses of the glaze/slip coating should be repaired after cleaning of the terra-cotta, by the application of a tinted breathable masonry coating carefully selected to be color matched to the original terra-cotta - ie, a light cream-stone color. The known appropriate coats are:

Conservare BMC, ProSoCo, Kansas City, Kansas US
Keim Granital, Keim gmbh, Germany
Minasil Mineralfarben, MCS Chemie, Salzburg, Austria

Field testing and research of the selected manufacturer's literature would be required to determine if the above coatings could be applied over the Jan Mortar repairs.

Following a carefully organized test program, the rust stained and soiled terra-cotta should be cleaned. The limestone cornice of the 2nd storey should also be repaired and cleaned.

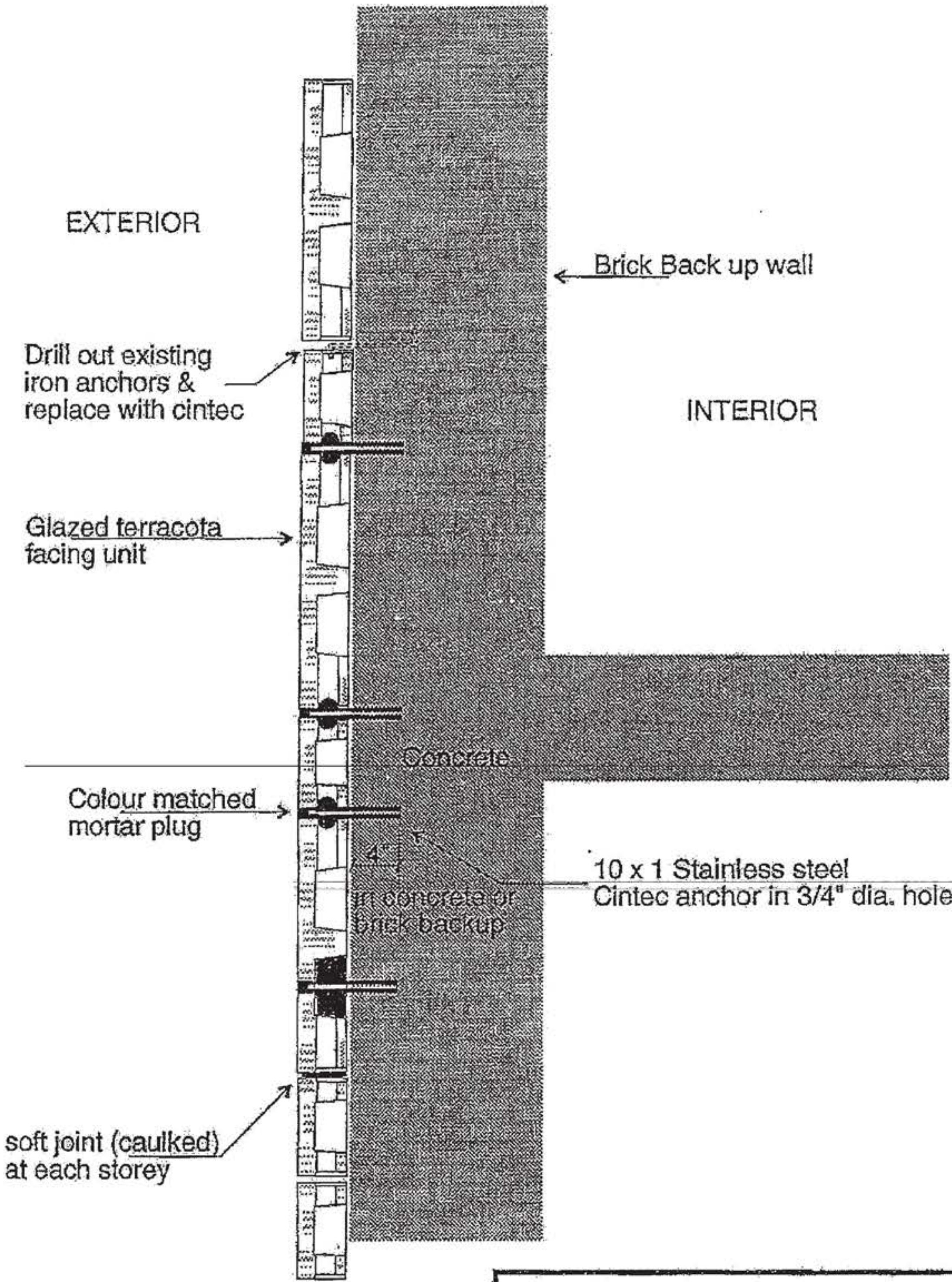
Spall damage should be repaired by careful cutting out and the insertion of matching Indiana Limestone Dutchmen. Cleaning of the limestone should be by means of nebulous spray washing and limited use of neutral, non-ionic detergents such as Triton X100. Following appropriate testing and the establishment of successful techniques, rust staining may be removed using Ferric Stain Removing Poultices from ProSoCo.

BRICK FACADES

The east, west and south facades, except for the terra-cotta returns at the north end of the building, are clad in a fired clay brick, which has been painted.

However, observation from the ground with binoculars and from the observation bucket indicated that these walls were in no immediate danger.

Deterioration was noted at shelf angles at a number of locations, particularly near the top of the building. This appears to be typical damage caused by the expansion of products of corrosion of the shelf angles.



UMA Engineering Ltd.
Engineers & Planners

Typical Terracota Anchoring Detail

DRAWN BY NO	JOB NO.	SHEET NO.
DESIGNED BY EJ	SCALE	9
CHECKED BY	DATE	

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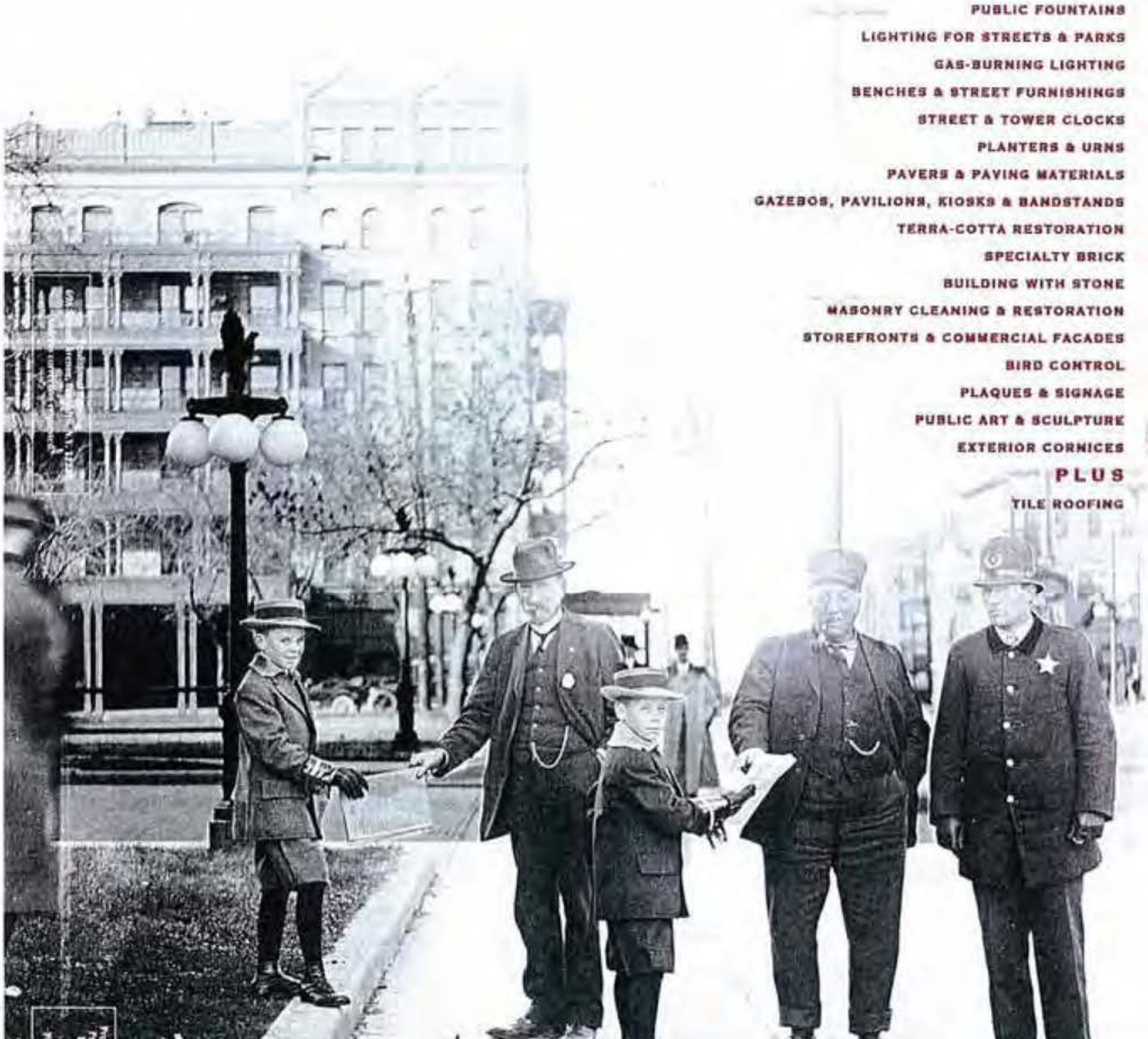
SPECIALTY BRICK
BUILDING WITH STONE
MASONRY CLEANING & RESTORATION
STOREFRONTS & COMMERCIAL FACADES
BIRD CONTROL
PLAQUES & SIGNAGE
PUBLIC ART & SCULPTURE
EXTERIOR CORNICES

PLUS

TILE ROOFING



CONSERVING A TERRA-COTTA CORNICE

A treatment report by Conservation Solutions, Inc., on a terra-cotta cornice adorning the Capitol Building in San Juan, Puerto Rico, shows the potentially catastrophic effects of corrosion in a marine environment, and offers some innovative solutions to the problem.

by Joseph Sembrat, *Head Conservator and President of Conservation Solutions, Inc.*

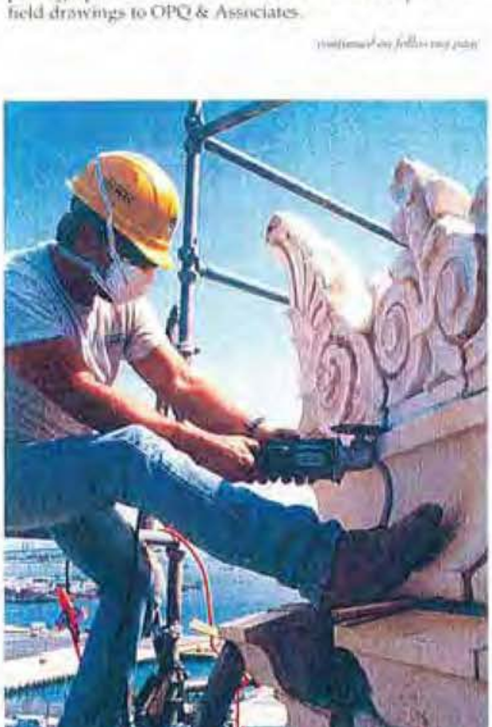
Conservation Solutions, Inc., was contracted by the government of Puerto Rico to assist Pablo Quinones of OPQ & Associates in the investigation of the main terra-cotta cornice at the base of the dome of San Juan's Capitol Building.

CSI subcontracted the services of Martin Weaver, President of Martin Weaver and Associates International Conservation Consultants (MWAICC), who performed investigative work and partial disassembly of a 6-ft. section of the cornice. This was done in order to prevent the collapse of this section of the cornice, determine the cause and nature of the failure, better understand the materials and techniques used in its construction, and provide the architect with various design solutions, cost estimates, and assistance with the writing of specifications.

The Capitol Building of Puerto Rico was inaugurated on February 11, 1929, as the seat of the Legislative Branch of the Puerto Rican Government. A vast marble staircase faces Ponce de Leon Avenue and gives access to the building to the south. Eight Corinthian columns rise at both main entrances and seven imposing doors give access to its interior at the north and south. At the center of the structure there is a rotunda which extends upwards to the three floors of the building, and in the center of the first floor there is a display case which has the original Constitution of Puerto Rico permanently on display. The cornice adorns the base of the dome which rises at the center of the building on an octagonal drum.

To help understand the condition of both the terra-cotta anchoring system and the concrete substructure that supports it, and to assist the clients in their portico-restoration project, CSI conducted an on-site investigation of the terra-cotta cornice and concrete substructure from scaffolding. CSI and Martin Weaver performed written and photographic documentation of the work and provided field drawings to OPQ & Associates.

continued on following page

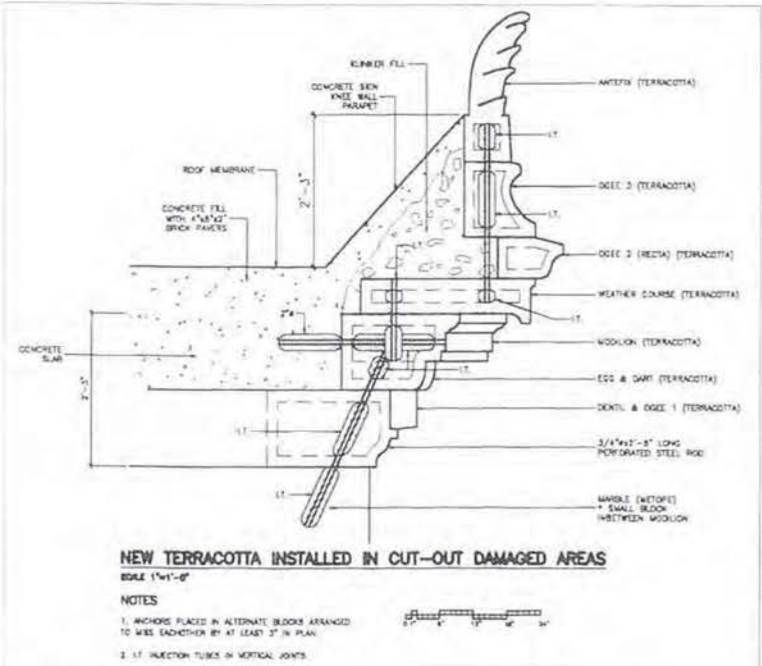


A worker is seen here cutting the mortar joints between the terra-cotta blocks in preparation for the disassembly of the cornice.

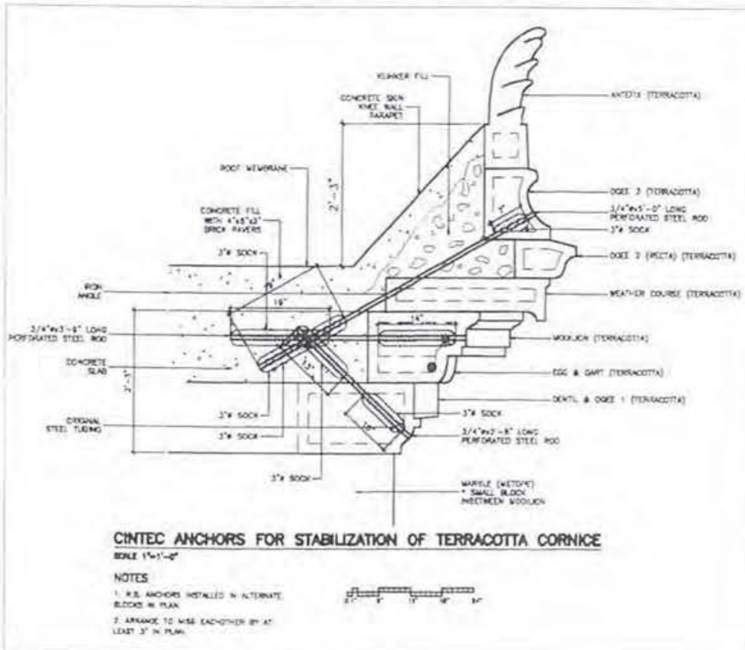
Puerto Rico's Capitol Building, or "El Capitolio," in San Juan, was completed and inaugurated in 1929. A major port city, San Juan faces the Atlantic Ocean to the north. This marine environment was a major factor in the dangerous corrosion of the anchoring system of the building's terra-cotta cornice.

The poor condition of the terra-cotta cornice is evident in this view. The separation of the terra-cotta units is due to not only the failure of the anchoring system, but also the expansion of the corroded material.

Once the cornice had been partially disassembled, the materials and techniques used in its construction could be easily identified. Note the clinker concrete, or "cindercrete," between the terra-cotta blocks and the brick backup material, and the severe deterioration of the steel supports. CSI recommended that all new steelwork be AISI Type 316 stainless steel, a non-corroding type, which is essential in this chloride-rich maritime environment.



Conservation Solutions, in collaboration with the project architect and conservation consultant Martin Weaver, designed these two new anchoring systems for the cornice. The design for the dismantled section (above) uses AISI Type 316, non-corroding stainless-steel rods in a grout-injection anchor system by CINTEC. Small injection tubes are positioned in the joints between the terra-cotta units for inflation with grout after assembly. The stabilizing anchors (below) are designed to be installed in-situ by means of a different type of CINTEC grout-injection system, also using AISI Type 316 stainless-steel rods.



Most importantly, we disassembled approximately 6 feet of the cornice to reveal its construction and its anchoring system. We also exposed a portion of the parapet decking to determine the condition of the underlying concrete substructure. In collaboration with the architect and Martin Weaver, a new anchoring system was designed. We also worked with the noted terra-cotta manufacturer, Gladding, McBean, to determine which sections of terra cotta would need to be replicated.

Finally, after our investigative work was done, CSI made the opening in the cornice watertight.

Following observation of severe cracking and movement at the corners of the main terra-cotta cornice of the octagonal lower drum of the dome, it was jointly decided to erect scaffolding and to carefully make an exploratory opening into the terra-cotta work.

The purposes of this intervention were to establish if the cracking and movement were evidence of a dangerous situation, to establish the types, locations, and conditions of the hidden steel support structure and anchors, and to establish the type, location, and condition of the reinforced concrete sub-structure.

We selected the southeast corner of the octagonal lower drum, apparently the area of the cornice with the worst conditions, as the best site for our investigations. Pablo Quinones and Martin Weaver had noted what appeared to be evidence of severe damage in this same area in 1998.

As the careful cutting away commenced at the cornice's upper level, we found that the cornice was backed-up by a mass of "clinker concrete" or "cindercrete." This material is based on an aggregate of furnace ash and large fragments of clinker. Its use has been suspended for many years because the large quantities of sulfur compounds present in the ash and clinker have been found to cause severe corrosion of adjacent steel in the presence of moisture.

After removal of the cindercrete from the adjacent area, the cutting-out proceeded and it was noted that the movement of the terra cotta was beginning to accelerate. The terra-cotta mass at the corner — probably weighing in excess of 500 lbs. — was pulling away from the main mass of the cornice by active diagonal cracks propagating down on either side of the corner. The unstable mass was immediately secured by ropes and temporary supports and was carefully cut apart and removed.

Water had penetrated down into the cornice, and all its steel structural supports and anchors had been totally destroyed by corrosion. The total failure of the structural-support steel and anchor system had led to the structural failure of the cantilevered, and now unreinforced, terra-cotta cornice. The only reason that it had not collapsed was a combination of the cohesive and frictional effects of the mortar and brick fragments used as back-up to the hollow terra-cotta units.

Moisture had entered via open joints and cracks and, to a lesser extent, through leaks in the roof above and behind the cornice.The reason for the extreme corrosion of the steel was a combination of chlorides from sea spray and the sulfuric acid formed when saline moisture saturated and then passed through the contaminated cindercrete. The corrosion had been so severe that it was no longer possible to establish the exact dimensions of any of the former steel elements. Some had disappeared totally, leaving only rusty stains in the terra-cotta work.

It should be noted that any corrosion of embedded steel is associated with massive expansion of the corrosion products. In the case of the Capitol Building, this expansion had resulted, and will continue to result, in the shattering of the immediately adjacent terra cotta. Thus, all stabilization, conservation, and restoration work must involve the removal of all corroding steel and/or the prevention of any further corrosion and associated expansive effects. All new steelwork must be AISI Type 316 stainless steel, which is non-corroding in the chloride-rich maritime environment present here. AISI Type 304 stainless steel is attacked by chlorides and cannot be used here under any circumstances because it will corrode.

On the basis of our observations, we concluded that in any and all locations where the terra-cotta cornices show evidence of cracking and movement, with open joints and possibly rust staining on the lower surfaces, then this terra-cotta work has had all, or most, of its structural-support steel and anchoring system so severely corroded that it is either totally gone or is so seriously deteriorated that the whole cornice, or parts thereof, are liable to become dangerous and could collapse suddenly and without further evidence of failure.

The extreme nature of the deterioration process was such that it will inevitably lead to catastrophic failure, with collapse of the terra cotta onto, and possibly through, the openings in the roof below. Accordingly, we recommended that all cracked and deformed areas of the cornice should be carefully dismantled as soon as possible. Shattered terra-cotta units should be replaced with high-quality matching new units from a well-established terra-cotta manufacturer such as Gladding, McBean of California. This firm has been in continuous practice since before the erection of the Capitol and is known for the high quality of its architectural terra cotta.

The dismantled corners should be rebuilt using AISI Type 316, non-corroding stainless-steel rods in a grout-injection anchor system by CINTEC, specially designed with small injection tubes positioned in the joints between the terra-cotta units for inflation with grout after assembly.

Undamaged areas of terra cotta may be stabilized in-situ by means of a different type of CINTEC grout-injection anchor system, also using AISI Type 316 stainless-steel rods. It will be necessary to open up a series of areas in the terra-cotta work at random locations to determine if, in fact, the apparently undamaged terra cotta can be safely stabilized in this way.

Once the water has been prevented from getting into the top of the cornices and other details, and the CINTEC in-situ stabilization system has been applied in diamond-tipped core-drilled holes, the crucial factor then will be whether any existing embedded steel can be left in-situ. All in-situ stabilization work must involve dry-drilling with advanced air-cooled drilling equipment. Under no circumstances can water-cooled drilling systems be used because of the danger of the water causing further deterioration.

It was recommended that a complete condition survey of all the terra-cotta work should be carried out as soon as possible to locate any other dangerous areas which may already exist. ■

Joseph Sembrat is President and Head Conservator of Conservation Solutions, Inc., District Heights, MD. The firm specializes in the conservation of historic structures, monuments, sculpture, and fountains in such materials as metal, stone, and terra-cotta.

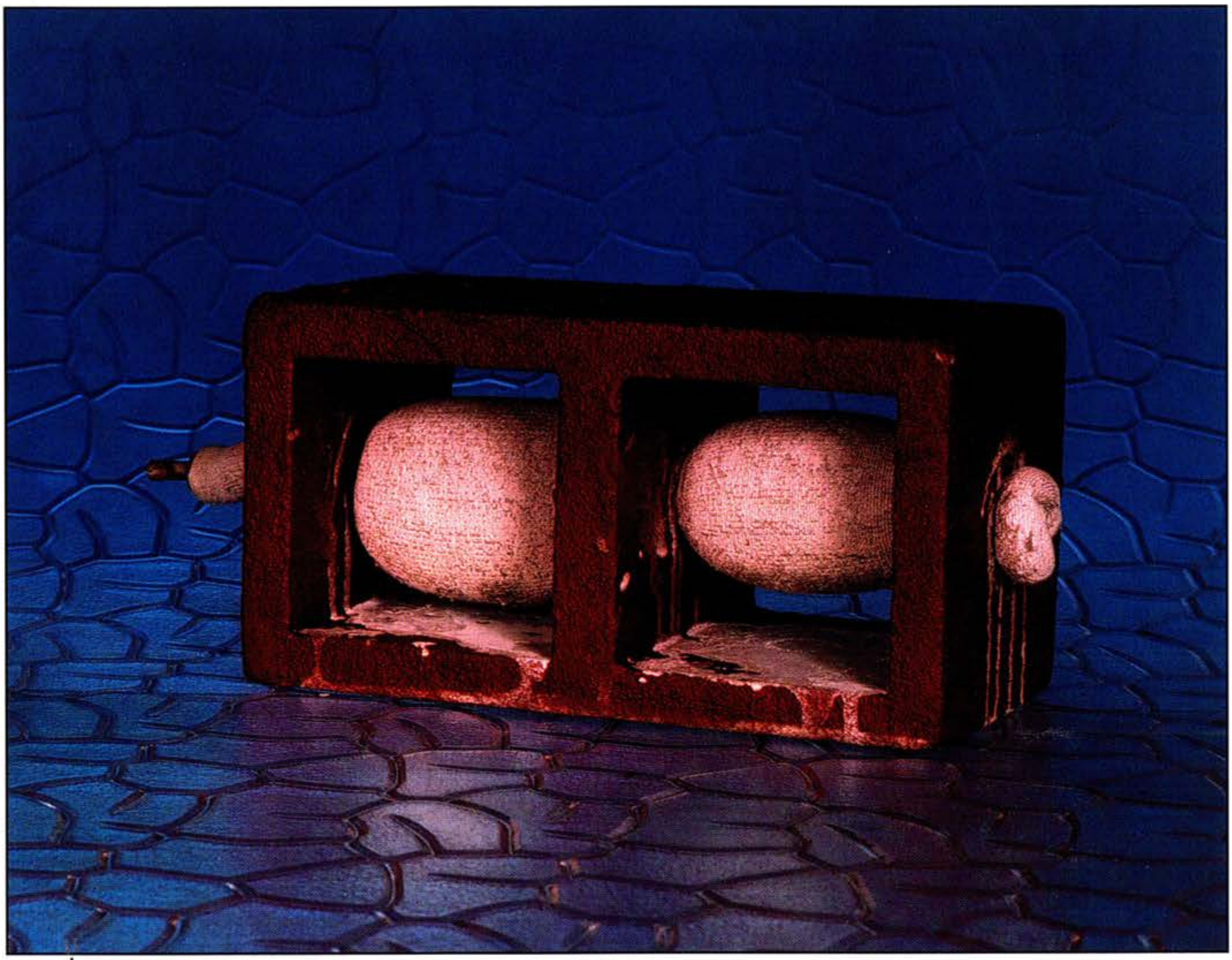
CI/SfB	Us/Ca	Xt 6	

CINTEC

ENHANCED FIXING TECHNOLOGY FOR TERRA-COTTA AND HOLLOW MASONRY UNITS

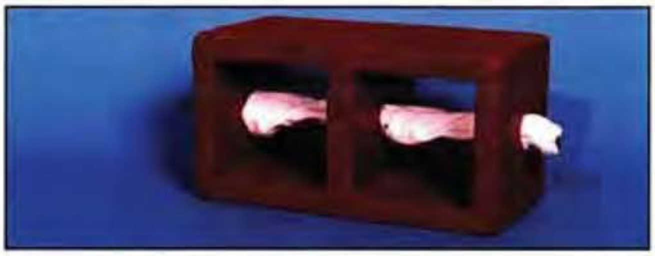
NOUVELLE TECHNOLOGIE D'ATTACHEMENT POUR TERRE CUITE ET ÉLÉMENTS CREUX DE MAÇONNERIE

NUEVA TECNOLOǴIA DE FIJACIÓN DE CERÁMICA Y UNIDADES DE MAMPOSTERÍA EN HUECO



CINTEC

DESIGNED ANCHOR SYSTEMS
SYSTÈME D'ANCRAGES ÉTUDIÉS
SISTEMAS DE ANCLAS DE DISEÑO



THE CINTEC ANCHOR IS INSERTED INTO A PREDRILLED HOLE.

L'ANCRE CINTEC EST INSÉRÉE DANS UN TROU PRÉ-PERFORÉ.

EL ANCLA CINTEC ES INTRODUCIDA EN EL ORIFICIO TALADRADO.

THE INJECTION EQUIPMENT IS ATTACHED TO THE ANCHOR AND INFLATION COMMENCES UNDER A PRESSURE OF 42 P.S.I.

LE SYSTÈME D'INJECTION EST ATTACHÉ A L'ANCRE ET LE GONFLAGE COMMENCE SOUS UNE PRESSION DE 42 P.S.I.

EL EQUIPO DE INYECCIÓN ES FIJADO AL ANCLA Y COMIENZA A INFLARSE A UNA PRESIÓN DE 42 P.S.I.

GROUT IS PUMPED INTO THE HOLLOW STEEL SECTION WHICH FLOWS INTO THE SOCKED AREA VIA A NUMBER OF FLOODED HOLES.

LE MORTIER EST POMPÉ DANS LE TUBE D'ACIER ET S'INFILTRE DANS LA GAINE PAR DE NONBREUSES OUVERTURES D'ÉCOULEMENT.

EL CEMENTO ES BOMBEADO EN LA SECCIÓN HUECA DE ACERO PARA POSTERIORMENTE FLUÍR A TRAVERS DE NUMEROSOS AGUJEROS HACIA EL FORRO.

AS THE ANCHOR FILLS, GROUT MILK FLOWS THROUGH THE SOCK CREATING A CHEMICAL BOND BETWEEN ANCHOR AND SUBSTRATE.

CINTEC

EN REMPLISSANT L'ANCRE, LA LAITANCE DU MORTIER PÉNÈTRE LA GAINE ET FORME UNE LIAISON CHIMIQUE ENTRE L'ANCRE ET LE MATÉRIAU SUPPORT.

CUANDO EL ANCLA SE LLENA, LA LECHE DE CEMENTO PENETRA EL FORRO Y FORMA ASI UNA REACCIÓN QUÍMICA ENTRE EL ANCLA Y EL SUBSTRATO.

AFTER APPROXIMATELY 15 SECONDS THE ANCHOR IS TOTALLY INFLATED WITH A MICRO FINE CONCRETE GROUT GIVING A MECHANICAL FIXING. IN ADDITION, THE GROUT MILK HAS PASSED THROUGH THE SOCK FORMING A CHEMICAL BOND TO THE SUBSTRATE.

APPROXIMATIVEMENT 15 SECONDES PLUS TARD, L'ANCRE EST TOTALEMENT REMPLI AVEC DU MORTIER A BÉTON MICRO FIN QUI PRODUIT UN ATTACHEMENT MÉCANIQUE.

APPROXIMADAMENTE 15 SEGUNDOS MÁS TARDE EL ANCLA SE LLENA TOTALMENTE DE CONCRETO MICROFINO PRODUCIÉNDOSE UNA FIJACION MECANICA.

DOUBLE FIXING CAPACITY.
LA CAPACITÉ D'ANCRAGE EST DOUBLÉE.
DOBLE CAPACIDAD DE FIJACION!!!

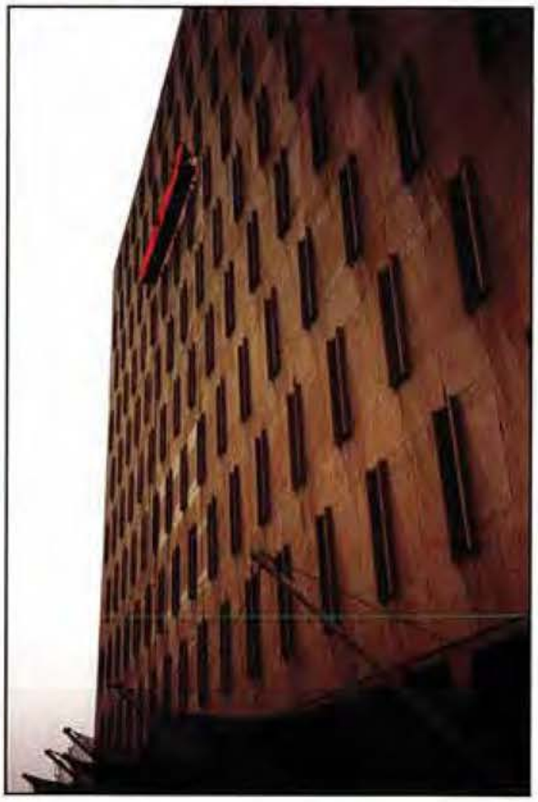
IN TESTS CARRIED OUT BY AN INDEPENDENT LABORATORY ON A BUILDING OF SIMILAR MATERIAL, AXIAL PULL RESULTS IN EXCESS OF 3000 LBS. WERE ACHIEVED.

LES ESSAIS EFFECTUÉS PAR UN LABORATOIRE INDÉPENDENT SUR UN BÂTIMENT DE MATÉRIAU SIMILAIRE ONT RÉVÉLÉ DES RÉSULTATS DÉPASSANT 1300 KG SUR LA TENSION AXIALE.

EN ENSAYOS LLEVADOS A CABO POR LABORATORIOS INDEPENDIENTES EN UN EDIFICIO DE MATERIALES SIMILARES SE CONSIGUIO UNA PRESION AXIAL DE MAS DE 3000 LBS.

TEST RESULTS AVAILABLE ON REQUEST – RÉSULTATS DISPONIBLES SUR DEMANDE – LOS RESULTADOS A SU DISPOSICIÓN, MEDIANTE SOLICITUDE.

INTERNATIONAL PROJECTS
PROJETS INTERNATIONAUX
PROYECTOS INTERNACIONALES

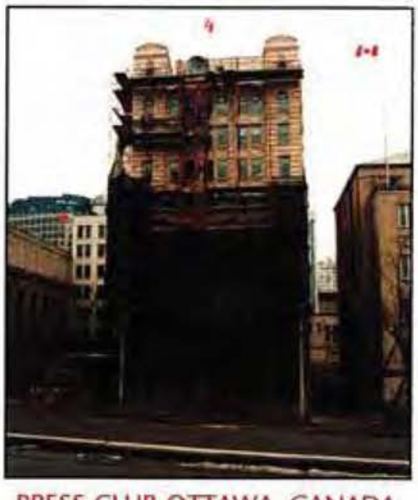


THIS DESIGNED ANCHOR SYSTEM WAS USED IN THE ESSEX COUNTY NEW COURT HOUSE & JAIL NEWARK, NEW JERSEY, USA. FOR FURTHER INFORMATION CONTACT OUR TECHNICAL DEPARTMENT.

CE SYSTÈME D'ANCRAGES ÉTUDIÉS A ÉTÉ UTILISÉ AU NOUVEAU PALAIS DE JUSTICE ET PRISON DU CONTÉ D'ESSEX, NEWARK, NEW JERSEY -E.U.. POUR TOUS RENSEIGNEMENTS SUPPLÉMENTAIRES, CONTACTER NOTRE DÉPARTEMENT TECHNIQUE.

ESTE SISTEMA DE ANCLAS DE DISEÑO FUE UTILIZADO EN EL PALACIO DE JUSTICIA DE NEW JERSEY.

PARA MÁS INFORMACIÓN, CONTACTAR CON NEUSTRO DEPARTAMENTO TÈCNICO.



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